Telephone Engineer

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Go to the Convention

As usual in the month of October, Independent telephone men from all parts of the country will gather at Chicago for the annual meeting of the United States Independent Telephone Association. The necessity of increased space has caused the transfer of convention headquarters from the Hotel Sherman to the new Hotel Stevens on Michigan Boulevard.

Many telephone men will regret leaving the hospitable roof of the Sherman, which has housed the convention for many years, but it is felt that the change will be for the better. For several years, exhibits have taken up all available space in the Sherman and have overflowed into the halls. Many exhibitors felt the limitations to the extent that they were not able to display their wares in a favorable way as they wished. The larger facilities of the Stevens will also make for greater convenience and comfort during the luncheon and entertainment of the Independent Telephone Pioneer Association on Thursday of convention week.

It is to be expected that the exhibits will be all the more interesting and instructive on account of the better facilities and the program is promised to be of the high standard of recent years. In addition to the main program, the divisional meetings will attract department executives who will have the opportunity of gathering to discuss latest developments in the work of their departments.

The national convention is an event of importance to all companies large and small. Every telephone company should be represented not only by one person, but by as many of its people as possibly can arrange to be present.

The Mutual Farm Line Again

We attended a district telephone meeting a short time ago. As in most other district meetings, especially in the great middle west, the discussion turned to the topic of securing satisfactory service on the subscriber owned farmer line. The usual variety of suggestions were made to secure improvement in conditions but no one seemed very sanguine as to probabilities of success of any of the suggestions.

Even representatives of mutual switchboard associations complained of their inability to secure cooperation from some of the lines centering in their switchboards. It is a problem that the present generation of telephone men have inherited from their predecessors and which undoubtedly they will pass on to their successors. This does not mean that improvement will not be made but it does mean that continuous effort will have to be expended to prevent the situation from becoming hopeless and to secure as much improvement as possible.

The difficulty goes back to the state of mind of the individual member of the mutual line. To him the line is a neighborhood institution and he seldom pictures it as anything else. He does not visualize his telephone as a unit in a country wide system of communication. He is willing to pay a certain amount of money and to spend a certain amount of time if—and here is the rub—every one else on the line will do likewise, but he will be blamed if he will get out and work on the line if John Soandso who is also on the line never gets out and does his share.

The ideal condition of course is to have all of the farm lines owned and maintained by commercial companies of the right type who will furnish first class service and collect a rate accordingly. But this ideal will be a long time in its realization. In the meantime effort will have to be directed toward reaching the individual on the mutual line because it is only through reaching him that hope of improvement lies.

Much improvement in farm practice in general has been the result of activities of state agricultural colleges, county agricultural agents and farm organizations. In the main their aim is to reach the

individual farmer and their success has been proportional to their ability to reach the farmer as an individual. If an effort is being planned to improve the mutual telephone line service, the methods of these agencies can well be studied and adapted to the requirements of the telephone situation.

Stock Prices A. T. & T.

One of the developments of the present bull movement in securities has been the pushing up of prices of utility securities to unheard of levels. American Telephone and Telegraph stock climbed above $300 per share at one time and still hovering around that point at the time this is written. On the basis of present number of shares, this would give a market value of about four billion dollars for the A. T. and T. stock outstanding.. The stock sold at over thirty times its annual dividend rate and at about twenty to twenty-five times its net earnings per share.

Just how much the rise has been due to present speculative interest in common stock, how much to investment trust buying and how much to other causes can not be determined. The floating supply of the stock has been small in spite of its wide diffusion. Most of the several hundred thousand stockholders own only a small number of shares acquired at prices substantially below the present market and are holding their shares for the dividend return and the profit from rights which have been a regular feature of the company's financial operations in past years.. It is probable that some of the larger blocks, the largest of which is less than one per cent of the total number of shares, are equally closely held.

The announced policy of the management is against stock split-ups and special dividends. It will be interesting to see if this policy can be maintained along with the policy of wide diffusion of the stock if the present market prices hold for any considerable length of time. At its present price, the stock is a rich man's buy rather than a buy for a man of moderate means who desires a stock having features of stability and marketability along with a rate of return above savings bank or government security rates. If these prices are maintained the stock will tend to find its way into the hands of fewer owners of large means than of more owners of small means.

Why Not Standardize Rates for Supplemental Service

Commercial departments of most telephone companies have had their attention directed toward the possibilities of increased revenue through the sale of extension stations and other supplemental services. Some companies have succeeded in selling these supplemental services and have realized a nice gain in revenue from them while other companies have done little and still seem to be in doubt as to whether it is a profitable undertaking.

One of the questions that must be met before undertaking the sale of such services is the question of rates to be charged. Doubt as to what a proper rate for certain of the services has caused some companies to defer offering those services. It is the old problem of placing the price at a place that will yield a profit and still make the service popular,

It would seem that there is opportunity for study of this matter and exchange of information. Perhaps it would seem to be extreme to suggest that there might even be a pretty well standardized schedule of charges for these supplemental services. Yet there would be many advantages if some kind of a standardized schedule were provided, even if it only suggested maxima and minima for the various services.

The ordinary objections against standardized rates for main station services would not apply as the supplemental services are in the nature of conveniences for those who can afford and are willing to pay for them. They are not necessities in the sense that main station service is.

May we suggest this as a subject for study and discussion in the meetings of the commercial division at the coming convention of the U. S. Independent Telephone Association.

Do Not Omit the Fall Line Patrolling

At this time of year most of the construction programs are well toward completion. The outside forces are settling back to the job of maintenance of the plant over the winter season. The splendid fall months are normally the period of lightest trouble in the plant. Spring and summer thunder and wind storms no longer furnish their quota of service interruptions and winter snows and sleet are still weeks away.

The period when the ordinary run of trouble is light gives the time for systematic patrolling of the lines to make the many minor repairs, neglect of which may mean line failures later. Insulators can be replaced, slack wires evened, weak poles reset or replaced, corners guyed and brush trimmed. A small gang will cover many miles of line during a few weeks of fine fall weather. The work they will do may save many times that amount of work in the season of rain, snow and sleet, bad weather, bad roads and freezing temperatures.

United States Independent Telephone Association Convention

PROGRAM

United States Independent Telephone Association, Thirty-third Annual Convention, October 22-25, Hotel Stevens, Chicago

Tuesday, October 22, 9:30 A. M.

Annual Meeting of Board of Directors.
Opening of Exhibits.
Registration of Members and Visitors.

General Opening Session, Tuesday, 2:00 P. M.

Reports of Officers and Chairmen of Divisions.
Appointment of Committees.
Miscellaneous Business.

Annual Dinner and Conference of State Association Executives, 6:00 P. M.

"The State Convention," by Frank L. McKinney, Secretary of Ohio Independent Telephone Association, Columbus, Ohio.

"District Meetings," by J. C. Crowley, Jr., Secretary-Treasurer of Minnesota Telephone Association, St. Paul, Minnesota.

General Session, Wednesday, October 23, 9:30 A. M.

President's Annual Statement, by F. B. McKinnon, Chicago, Illinois.

Address—"Increasing the Net Profits," by John H. Agee, Vice-President and General Manager of Lincoln Telephone & Telegraph Company, Lincoln, Nebraska.

Address—"The Rochester Campaign for New Subscribers," by Frank T. Byrne, Commercial Superintendent of Rochester Telephone Company, Rochester, New York.

Reports of Committees.
Election of Directors.
General Business.

Division Conferences, Wednesday, 2:00 P. M.

ACCOUNTING DIVISION CONFERENCE:

Statement of Changes in Accounting System Proposed by the Bureau of Accounts of the Interstate Commerce Commission, by E. C. Towner, Auditor of Disbursements of Tri-State Telephone & Telegraph Company, St. Paul, Minnesota.

COMMERCIAL DIVISION CONFERENCE:

Discussion of Development of Business Topics presented at Morning General Session.

PLANT DIVISION CONFERENCE:

Report of Committee on Protection Against Lightning by Association's Representatives, W. L. Cook of Reliable Electric Company, and John S. Baker of Cook Electric Company.

Report of Committee on American Standard Electrical Definitions by Association Representative, Dr. Arthur Bessey Smith of Automatic Electric Company.

"Teletypewriters," Explanation and Demonstration by A. S. Benjamin, Sales Engineer, Teletype Corporation, Chicago, Illinois.

TRAFFIC DIVISION CONFERENCE:

Discussion of the Evolution of Toll Traffic Methods, and other topics.

Annual Meeting of Pioneers' Association, Thursday, October 24, 10:00 A. M.

Business Session.

Address by Hon. Frederick A. Landis, Logansport, Indiana.

Annual Luncheon and Entertainment.

Annual Meeting of Program Service Division, Friday, October 25, 9:30 A. M.

Addresses and Discussions by J. A. Gustafson, A. L. Geiger, Ray Manson, O. C. Levy, R. S. Brewster and George R. Eaton.

The ninth annual convention of the Independent Pioneer Telephone Association will be held at the Hotel Stevens, Chicago, October 24th, which is the third day of The United States Independent Telephone Association, held October 22nd to 25th, inclusive.

The morning of the 24th the Pioneers will have a business session, followed by an address by the Hon. Frederick Landis of Indiana. Mr. Landis is nationally known as a speaker and entertainer. Immediately following the forenoon session is the annual banquet and entertainment. The entertainment committee has advised your secretary that they have a wonderfully interesting program. Those of you who have attended former Pioneer Days know what this means.

Be sure to visit these:

Exhibitors at U. S. Independent Telephone Association Convention

American Electric Company, Inc.
American Steel & Wire Company.
Automatic Electric Incorporated.
Bartlett Manufacturing Company.
L. M. Berry.
Lynton T. Block & Company.
Bright Star Battery Co.
The Brown Company.
The Buda Company.
Burroughs Adding Machine Company.
Carbon Products Company.
Chance Company.
Cleveland Trencher Co.
Coffey System & Audit Company.
Coffing Hoist.
Cook Electric Company.
Curtin-Howe Corporation.
Do/More Chair Company.
Electric Storage Battery Co.
Everstick Anchor Company.
Frankfort Lumber Company.
French Battery Co.
Highway Trailer Company.
Holtzer-Cabot Electric Co.
A. J. Johnson Electric Co.
J. K. Johnston.
James R. Kearney Corp.
Kellogg Switchboard & Supply Co.
Leich Elecric Company.
MacGillis & Gibbs.
Nilco Lamp Works.
National Carbon Company.
North Brothers.
Page & Hill Company.
Quick Directory Company.
Philadelphia Storage Battery Co.
John A. Roebling's Sons Company.
Reliable Electric Company.
Republic Creosoting Co., The.
Runzel-Lenz Electric Mfg. Co.
Sands Electric Company.
Signal Engineering Company.
Spooner & Merrill, Inc.
Stromberg-Carlson Tel. Mfg. Co.
Suttle Equipment Co.
Teletype Corporation.
Telkor, Inc.
Templeton, Kenly & Co., Ltd.
Unique Mfg. Co., Inc.
P. Wall Mfg. Supply Company.

Studying Telephone Methods

This Is Chapter 32 of a Series of Articles by E. R. Collins, Manitoba Telephone System, Brandon, Manitoba, Canada. This Chapter Deals with Line Switch Grouping and Method of Control by the Master Switch

In Chapter 31 the construction, and circuit operation, of the plunger type line switch was discussed. This chapter will continue the study of the Line Switch, dealing with the methods of grouping, and control.

A little time spent studying the cut in Fig. 255 will help to explain the arrangement of Line Switches in groups.

Line Switchboard or Upright

The line switches are commonly grouped in units of 100 switches. These are mounted on a steel frame work called a Line Switch Upright or Switchboard. The front of the board as shown in Fig. 255, is occupied by 100 line switches, and one master switch. The line switches are mounted in 4 clusters or groups, and in the centre of each cluster, will be noted a long white bar. This is the guide shaft or pickup bar. The two groups on the left are mounted on a common frame work which is hinged like a door, with the pivot points at the extreme left of the door. The same applies to the right hand side of the board, only the pivot points are on the extreme right. These two doors are referred to as line switch shelves. The doors are fastened in a closed position, by 4 machine bolts, screwed into the main frame work of the switchboard. This fastens the two shelves rigidly to the switchboard, and holds them in a fixed position in relation to one another. When the 4 bolts are removed, and the connecting link between the guide bars is removed, the two line switch shelves may be opened as two doors. This allows the workman to work at the back of the line switch shelves with ease. One point that will impress itself on the telephone man, who first inspects this type of equipment, is the careful planning that has been exercised to make every part of the equipment convenient to work at.

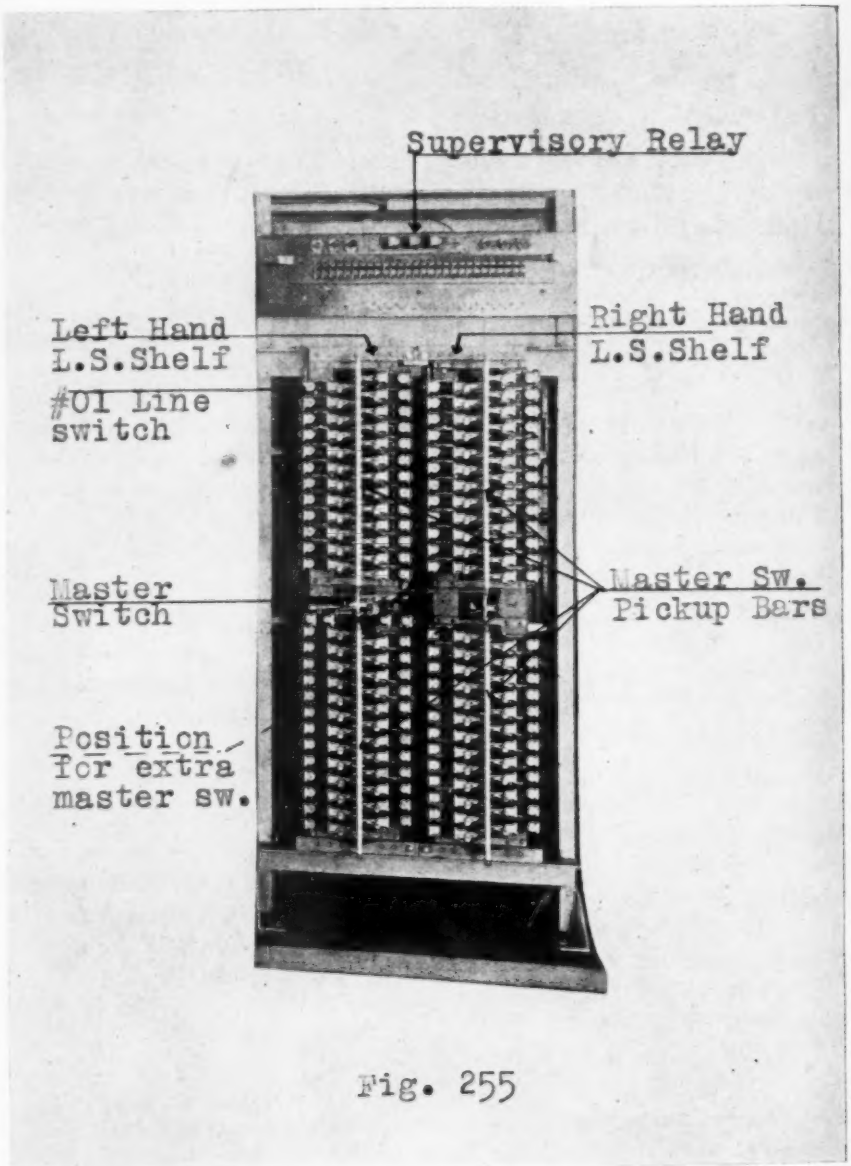

Fig. 255

Each line switch is supplied with a line switch bank. These banks are clamped to upright bars set at the back of the line switch shelf. The banks are carefully spaced by using gauges, so that each line switch bank is in proper position to allow the line switch plungers to enter the banks without binding. The wiring for the banks is brought out at the back of the line switch shelf, and formed into long gooseneck forms, so that the shelves may be opened and closed without injuring the wiring. These forms are taken to the upper part of the switchboard, where they terminate on a set of terminals. Fig. 255 does not show these terminals, but they will be discussed later. The line switches are each mounted on the front of the shelves with 2 machine screws. Each line switch must be lined up with all the others in the same group, in relation to the line switch banks, so that the one guide bar will be able to direct each line switch in the same position before each bank.

Arrangement of Trunks

On a manual switchboard, each operator is supplied with say 10 pairs of cords. She will also have a certain number of line lamps appearing in front of her. The number of lines allotted to each operator will depend on the volume of traffic from each telephone. One group of 25 lines may be as busy as another group of 100 telephones. The same rule applies to automatic.

We must provide sufficient trunks, or cord circuits, to suit the volume of traffic originating in that group. Unless we can do this, the system will not meet the demands of actual service. To accomplish this, the line switches are arranged in 4 separate clusters or groups. Each guide bar can be moved separately, or two or three or all four bars may be linked together as required. We will

suppose we have all 4 bars linked together. Then there will be a common movement to each line switch. The line switch banks, are arranged, so that they may be separated into 4 groups, corresponding to the line switch groups, or they may be wired in multiple, so that they appear as one group of 100 lines. In this case No. 1 trunk of No. 01 line switch will be wired in multiple with the No. 1 trunk of the other 99 line switch banks. The same will apply to No. 2 and the other trunks.

If we assign 100 lines to an operator, she will control all the traffic coming from these 100 telephones. If we assign 100 lines in four groups of 25 telephones to 4 operators, there will be 4 separate operators controlling the traffic from the same 100 lines. In the first case there will only be 10 pairs of cords to serve the 100 lines with one operator. In the second case there will be 40 pairs of cords with 4 operators. It naturally follows that the latter arrangement will handle a much larger calling rate, but will be relatively more costly.

In the automatic system, we have a device known as the master switch, which will take the place of the line operator. If all the 100 lines are grouped together with only 10 trunks, then there will be only one master switch. But if the 100 lines are arranged in 4 groups of 25 lines each there will be 4 master switches each with 10 trunks or a total of 40 trunks for the same 100 telephones. We can likewise break the 100 lines into 2 groups of 50 lines each. In this case there would be two master switches and 20 trunks. The position of the extra master switch is indicated in Fig. 255. If 4 master switches were used, the other two would be mounted where the words "Left Hand L. S. Shelf, and Right Hand L. S. Shelf" arrows are pointing.

You will notice that there are 4 rows of line switches, while there are only 2 rows of line switch shelves. No. 01 line switch has its coils to the left and the plunger to the right of the line switch assembly. The line switches in the next row to the right of No. 01 have their coils to the right and the plunger to the left of the line switch assembly. The line switch bank is located between these two rows of line switches. This means that we have a *right hand* and a *left hand* line switch, and this must be specified when ordering new line switches. This also means that the springs used on a right hand line switch relays will be of a different piece number to the springs used on a left hand line switch relays. This opens up the question of keeping piece parts which will be discussed in another chapter.

The Master Switch

The device that takes the place of the telephone operator, in directing the incoming traffic, is called a master switch. There are different forms in which this may be built, but the most common type will be studied here.

The master switch is mounted on the line switch shelf as shown on Fig. 255. The wiring to the switch is connected by the use of a set of springs called a jack. This jack takes care of all the wires necessary to connect the master switch to the other wiring of the switchboard. There is a main moving part of the switch shown in Fig. 256, under the name locking segment. This segment is built on a short hollow shaft. Each guide bar (of which there are 4 to each switchboard of 100 lines) is provided with a bearing shaft, at each end of the bar.

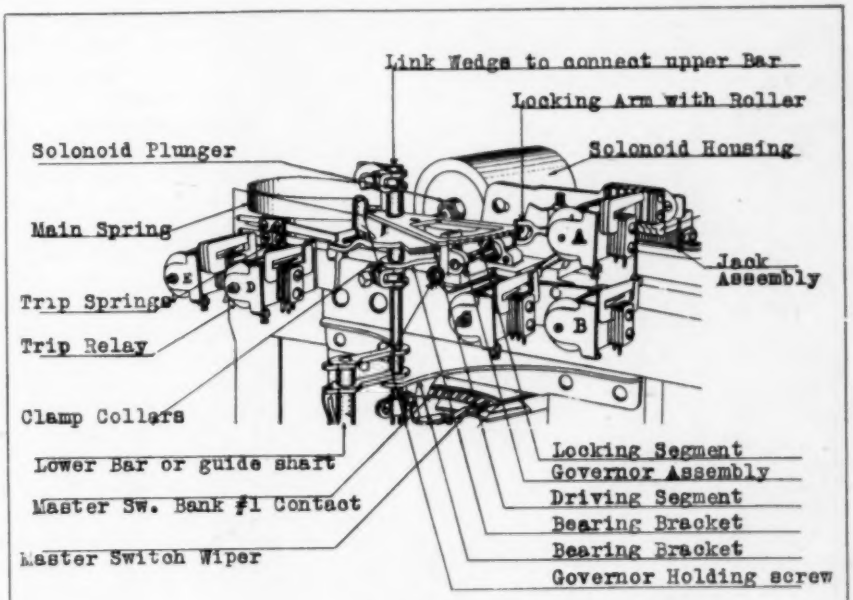

Fig. 256-

The upper shaft has a long projection, which extends upward through the bearing bracket, while the lower shaft has a shorter projection which extends down through the lower bearing bracket. The lower guide bar to the left in Fig. 255, will have a short projection at the bottom and a long projection at the top. The upper guide bar above it will have a long projection on the top and a short projection on the bottom. These projections are slotted, to admit a piece of metal called a key. When the upper and lower guide bars are locked together, the locking segment assembly is slipped over the long end of the lower guide bar with the key inserted in the slot of the shaft. Then the upper guide bar shaft is slipped into the upper end of the segment assembly, and turned until the upper part of the key fits into the slot in the upper bar shaft. There are two clamp collars which have previously been placed in position on the segment assembly. The upper and lower hollow shaft of this assembly are split. When these clamp collars are tightened, the split shaft clamps against the guide bar shafts and holds them.

When separate master switches are used on an upper and lower group of the same line switch shelf, the two guide bars must move separately. Therefore we remove the key and omit the upper clamp collar of the centre master switch. The lower guide bar will be clamped to the lower master switch, and the upper guide bar will be similarly clamped to the upper master switch, allowing each guide bar to be moved separately.

Provision is made to connect a link between the guide bars of the left hand shelf, and the guide bars of the right hand shelf. There is a turnbuckle link provided. Turning the adjusting link of this turnbuckle, will vary the distance between the guide bars. Therefore if the four guide bars were all controlled by one master switch, we would set the master switch connected to the left hand bars, on say No. 1 trunk. Then we could adjust the turnbuckle until the right hand guide bars, brought their line switch plungers, in the same position before No. 1 trunk, as that held by the line switches of the left hand groups.

There is a group of contacts shown in Fig. 256 called the master switch bank. There are 10 sets of contacts in this group which correspond to the 10 sets of contacts of the line switch banks. There will therefore be one master switch bank, supplied for each group of 25 line switches, and each bank is so wired that it may be multiplied with any of the other three banks.

The Solonoid and Main Spring and Governor

In Fig. 256 there are 5 relays shown. Only four of these will be mentioned in the following description. The start re-

lay (B), the locking relay (C), the trip relay (D) and the open main relay (E).

There is a solonoid, and a main spring, which supply the power to move the guide bars. There is a governor assembly, to govern the speed at which the guide bar shall travel, when moved by either the main spring, or the solonoid.

The locking segment and the driving segment and hollow shaft are cast in one piece. There are also two projecting arms cast on this assembly. These two arms operate the trip relay springs when the master switch wiper is on either the 1st trunk contact, or on the 10th trunk contact. These arms are provided with hard rubber insulators, at their tips, to prevent them making electrical contact with the springs of the trip relay.

Pivoted at the rear of the locking relay, is a casting with two arm extensions. The lower arm is provided with a hard rubber bushing, which lies between the armature of the locking relay, and the contact springs of the locking relay. The upper arm is equipped with a roller, which normally lies in one of the slots of

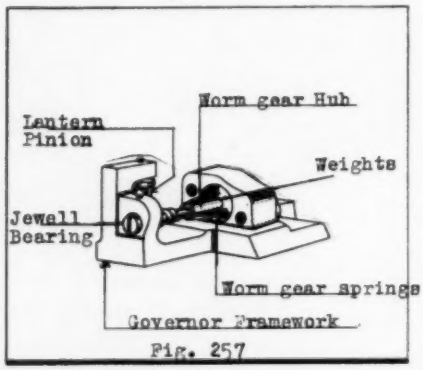

Fig. 257

the locking segment. There are 10 slots in this locking segment, one for each trunk position. The springs of the locking magnet have a stiff adjustment, so that the locking arm roller is pressed firmly into a slot of the locking segment. When the locking relay operates, it lifts the roller out of the slot, and allows the main spring, or the solonoid, to move the segment. There is sufficient pressure, to prevent this movement, when the roller is in any slot of the locking segment.

The driving segment is simply a section of a gear wheel. This is meshed into the pinion of the governor assembly. Any movement of the locking segment, therefore, causes a similar motion of the driving segment. The governor geared to this segment, will only permit being driven at a constant speed. Therefore, the speed at which the guide bars travel, is controlled by the governor.

The governor assembly is shown in Fig. 257. It is a separate and self contained unit. By removing the holding screw as shown in Fig. 256 the governor assembly may be pulled out. It is good practice to have one or more good governors in a dust-proof box, placed in some convenient place. Then if a governor sticks, it can be removed by taking out the one screw, and a good governor put in its place. And then, before you forget it, repair the defective governor, and replace it in the box for future use. A faulty governor will tie up the outgoing traffic from 100 telephones, so it must be replaced as quickly as possible. Keep one or more good spare governors always on hand in a convenient place.

In Fig. 257 is shown a cut of the governor assembly. This is of similar construction to the governor of the calling device or dial. In the dial, the governor is required to run in one direction only. The master switch governor must operate in both directions. The lantern pinion consists of two pinions on one common shaft. The upper small pinion meshes with the driving segment, while the lower pinion meshes with the worm gear. This lantern pinion may be made of metal, or fibre, or rawhide, or a combination of these. The combination of the brass and fibre wheel seems to give the smoothest operation. The ends of the governor worm gear shaft have quite an end thrust. The ends of the shaft must be carefully finished, and the end bearing screws provided with a crystal bearing surface, or a steel ball to reduce friction.

Solonoid Assembly

The solonoid consists primarily of a coil of wire wound on a non-magnetic spool. The magnetic field of a solonoid without any iron in the field, will find a high magnetic resistance. The construction of the coil must be such that the magnetic field loss is all confined to the core space. When this is done, there is a very intense, low resistance, magnetic field, surrounding the coil, but still a high magnetic resistance within the core space. The ends of the coil shown are therefore of high grade soft iron. The iron pole pieces are fastened together on a brass tube. If you examine the tube carefully, you will notice that there is a seam running the length of the brass. Brass is non-magnetic, but if there were no seam in the tube we would have a complete electric circuit of very low resistance around the core space. With a solid tube, we would have an effect similar to the slug on the slow acting relay. The current set up in the tube would oppose the current in the winding of the coil, and would have a tendency to slow up the action of the solonoid. The seam causes a high resistance break in the brass and the current flow is decreased.

The plunger of the solonoid is made to slide easily into the brass tube. The solonoid coil when energized, will try to overcome the magnetic resistance at the core, and the iron plunger is drawn in. When the core is fully inserted into the coil, the resistance of the magnetic field is reduced, and the plunger comes to rest. The plunger must therefore be so adjusted that it does not go into the coil the full distance. Then there will be still a pull as the coil tries to complete the magnetic field. The inner end of the plunger is hollowed out, as shown in the sketch. This provides an air cushion between the back of the housing and the plunger. The shape of the inner end of the plunger also serves to give a tapered high resistance to the magnetic field, so that there will be an inward pull on the plunger even after the back edge of the plunger has reached the housing.

The surfaces of the plunger and the brass tube must be smooth, and given some form of lubricant. This lubricant must be cleaned off occasionally to prevent the tendency of clogging with dust.

The solenoid has a threaded connecting rod, which is connected to the segment assembly of the master switch. This is adjustable so that the stroke of the plunger may be adjusted to suit the motion of the master switch mechanism.

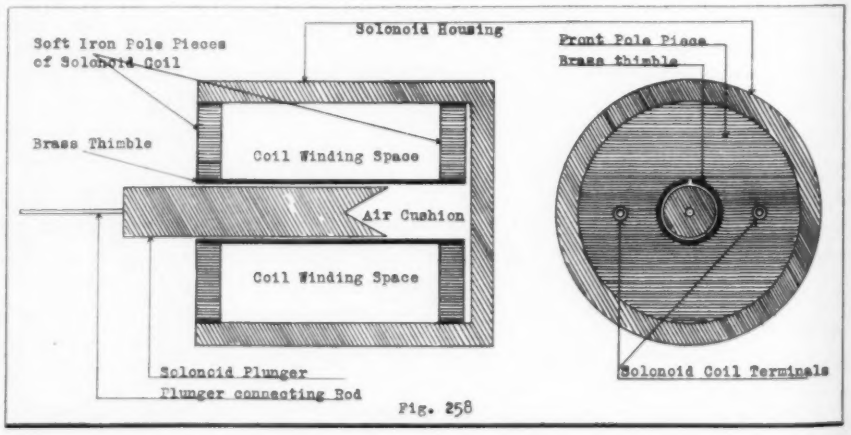

Fig. 258

Master Switch Circuit

Referring now to Fig. 259, we will try to explain the operation of the master switch mechanism. The solenoid is shown connected to the locking segment. There is also a heavy steel spring set between a solid support, and a bracket

of the locking segment. The force of the spring is applied at about the same point the pull of the solenoid is exerted. When the solenoid pulls in the plunger, the locking segment is pulled in, and pressure exerted on the spring. If the pull of the plunger is released, and the segment allowed to move, the spring would force it back again. The movement in either direction is controlled by the locking segment. The speed of the motion is governed by the governor assembly.

The extension arms of the locking segment are shown. The lower arm is shown pressing upwards against the horizontal springs of the trip relay. When the segment swings the other way the upper arm comes down and makes contact between springs 1 and 2.

There is a projection shown on the side of spring No. 3 of the trip magnet. This is so arranged that when the trip relay is pulled up, spring No. 4 passes to the right under the extension, and is hooked to the right of it, so long as spring No. 3 is allowed to press down against spring No. 4. Then when the segment arm (10) presses up on spring No. 3, it clears the projection from the tip of spring No. 4 and allows it to drop back against its armature which will then be released.

We have shown the master switch bank with No. 10 contact wired to a set of springs of a line switch bank. The other nine sets of line switch bank springs would be wired to the corresponding 9 sets of the same master switch bank. For simplicity we will deal only with the wiring of one set.

There is also shown the "B" relay of a selector or connector wired to this line switch bank.

We have also shown the pull down coil and its relation to the master switch circuit.

There is also a supervisory ground relay shown at the upper part of the drawing. This is located at the upper part of the switchboard. Its purpose will be discussed in a subsequent chapter.

There are 4 relays shown in the master switch assembly Fig. 259. They are (b-start relay), (c-locking relay), (d-trip relay) and (e-open main relay).

The master switch is shown in position at No. 10 trunk. If the line switch shown is operated on No. 10 trunk, the operation will ground the release wire of this line switch, and also a multiple of this wire will ground the No. 10 contact of the master switch bank. Then a circuit can be traced from battery through the winding of the *start* relay, over the wiper cord and wiper to the No. 10 contact of the master switch, to ground at the release trunk. The "B" relay of the selector or connector maintains this ground connection.

Start Relay

The start relay operates and its contacts close a circuit from ground at the supervisory relay, through the ½ ohm winding. This closes a circuit from battery through the 200 ohm winding of the locking relay to ground.

Locking Relay

The locking relay pulls up and closes its contacts. It also lifts the lock roller out of the segment slot. This allows the main spring to drive the segment out, and moves the master switch wiper into the next contact which we will assume for the present is dead. The contacts of the locking relay have meantime closed circuits to the open main relay, and the 1000 ohm winding of the supervisory ground relay. When the wiper reaches No. 9 contact of the master switch bank, and finds no ground, the start relay circuit is broken and it releases. This also releases the locking relay. The locking relay has a stiff adjustment, and is very quick to release. Therefore as soon as the wiper is on No. 9 contact the locking roller drops into the No. 9 slot of the segment and prevents it moving any further. Now the master switch guide bars have at the same time moved all the other line switch plungers to face No. 9 trunk, while No. 10 trunk is occupied by the one shown in Fig. 259.

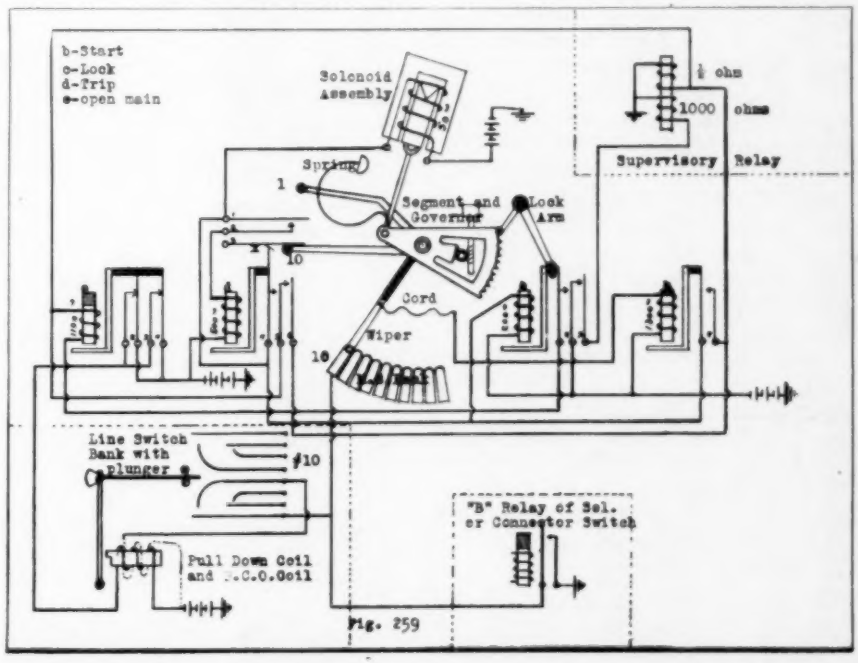

Fig. 259

Open Main Relay

The open main relay operates every time the locking relay pulls up, therefore its contact open. These contacts are shown in multiple. This gives double contact surface. This relay controls the battery feed to all the pull down coils of the line switches controlled by this master switch. It may have to carry the battery feed for only 25 pull down coils or the whole 100 coils. The purpose is to prevent any line switch from plunging while the line switch is in motion. This prevents any line switch from plunging until the master switch stops at a trunk that is not busy.

The operation above described is repeated when contact No. 9 is grounded and all other plungers are turned to trunk No. 8. When No. 8 trunk is grounded, operating the start, locking and open main relays, the main spring drives the guide bars until all line switches stand before trunk No. 7. And so on until trunk No. 1 is reached. When the master switch reaches trunk No. 1, the extension arm No. 1 closes the contact of springs 1 and 2 of the trip relay so long as the guide bars are facing No. 1 trunk. When a line switch plunges on No. 1 trunk, we find that *the start relay, the locking relay* and the *open main relay* operate as before. We can also trace a circuit from the No. 1 spring of the start relay to the No. 1 spring of the trip relay which is now in contact with No. 2 spring. Therefore battery will flow through the winding of the trip relay back to supervisory ground relay by way of the starting relay contacts. The trip relay operates and closes springs 4-5-6. But spring No. 3 is hooked over spring No. 4 now and locks up these contacts. Therefore 4-5-6 will remain in contact until the trip spring No. 4 is lifted. An additional ground circuit is now provided from the ½ ohm supervisory ground relay over contacts 4-5-6 so that if the start relay drops back the trip relay remains energized.

Solenoid Circuit

A circuit can now be traced from battery at the solenoid over contact of 4-5-6 trip relay springs, to the ½ ohm winding of the supervisory relay. This causes

(*Continued on page* 46)

Telephone Relays and Transformers

By F. J. DOMMERQUE
Fellow A. I. E. E.

Preliminary Remarks

In the discussion of circuit coupling a distinction was made between mechanical coupling and electrical coupling. The relay was mentioned as an illustration of mechanical coupling. In the latter two circuits are linked together, but they remain independent. The one circuit is is the power supply circuit for the relay, which has the sole purpose to energize the relay so that it will close or open, as the case may be, the set of springs which close or open the other circuit. There is no electrical connection of the two circuit effected nor intended.

An example of an electrical coupling is the telephone transformer. Whether the two coupled circuits have the coupling member in common, which is the direct coupling, or not as in a case of an indirect coupling, there is always an action from one circuit to the other or rather an interaction between the two circuits. In a telephone transformer we usually have an indirect coupling. The circuit in which the applied e. m. f. is found is ordinarily considered as the "primary" and the circuit acted upon as the "secondary" circuit. There exists, however, a case in which one winding serves as both primary and secondary (which represents a direct coupling) namely the "auto-transformer," in which at least one winding is common to more

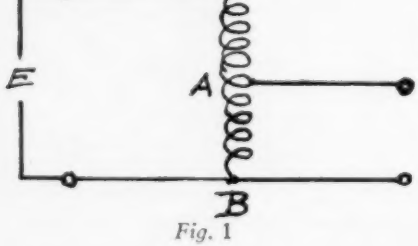

Fig. 1

than one circuit. In Fig. 1 is shown a simple form of an auto-transformer, in which the winding A B is common to both circuits.

When a wire is wound to a coil and a current is sent through it, a magnetic field is produced the intensity of which is increased in direct proportion to the number of turns in the coil. The magnetic flow density within the coil depends entirely upon the number of ampere-turns. This holds good for relays as well as for transformers.

In a telephone transformer we have two such coils wound mostly one upon the other, in the two coil circuits there exists mutual inductance between primary and secondary winding. In most cases the coils are wound upon a common iron core, which greatly increases the mutual inductance.

In relays we have an open core, also in some type of transformers, while others are of the closed core type, in which the magnetic flux is entirely through iron. The iron core is an essential part of the magnetic circuit, of which the armature in relays forms another part, the air gap in relays being necessary to allow of the free movement of the armature.

The Magnetic Circuit

Just like an electric current requires a complete electric circuit to flow, so there must always be a complete magnetic circuit for the flow of magnetic induction. Just as every flow of current is obstructed more or less by some substance offering a resistance, so a magnetic resistance is offered by some substances to the propagation of the lines of force. The relative capacity possessed by any substance for conducting these lines of force is its "permeability." The metals principally used for magnetic circuits, steel and iron, possess a permeability reaching as high as 2,500 or more, the permeability of air as a vacuum being taken as unity; powdered iron and permalloy, an alloy consisting principally of nickel and iron, reach a permeability many times higher.

The limit of magnetization in good wrought iron is about 20,000 lines per square cm.; it is not commercial to push the magnetization beyond 16,000 lines. Pure soft iron has in addition to its high permeability a low retentivity; that is, it will, soon after magnetization ceases, be deprived of the magnetizing effect. This is of importance in many cases of electromagnets which are required to develop as strong a field as possible at some particular point directly the current commences to flow, and to lose all traces of magnetization on the cessation of the current flow. Steel on the other hand always retains a large proportion of the magnetization imported to it, and if the magnetization is strong enough can be made a permanent magnet. The maximum magnetization of annealed uninsulated iron powder cores has been found to be about 13,600 lines per square cm. and of annealed and insulated iron powder which has passed through a sieve with 80 meshes to the linear inch and subjected to a pressure of 200,000 pounds per square inch, about 8,200 lines per square cm. Compressed powdered iron for loading coils is worked, however, at low magnetizing forces.

The hysteresis, that is the retarding effect of magnetization manifested by the difference between ascending and descending curves of magnetization, is of importance with respect to iron cores of magnets, where the magnetization is rapidly and repeatedly reversed, as this reversal effects a change of position in the molecules of iron, whereby energy is expended which is converted into heat.

The coercive force necessary to demagnetize a piece of steel or iron after it has been magnetized to any degree depends chiefly upon the nature of the material employed; the coercive force of soft iron is much lower than the coercive force of hard iron or steel.

As substitute for fine iron wire, powdered iron must have a permeability between 20 and 100 at low magnetizing forces, so as to be able to follow the rapid undulations of the currents. In general any iron core should be short to

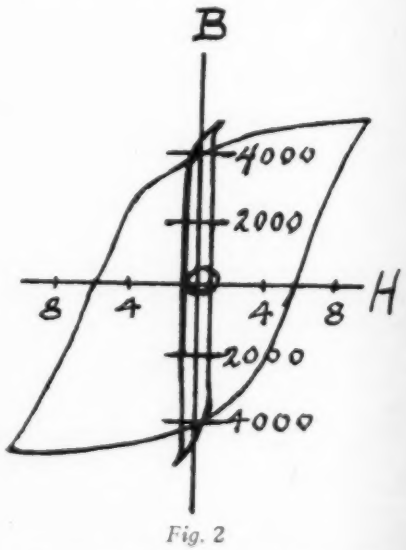

Fig. 2

secure mobility to the lines of force. The iron itself must be as soft and uniform as possible. Permalloy after a proper thermal treatment is extremely soft. It may be stated that the permeability for

very low magnetizing forces (at the limit of the magnetizing force H = O) is called the "initial permeability."

The hysterisis in all cores used in telephony should be kept low, so as to permit of a magnetization proportional to the magnetizing current. Where the magnetization has to accommodate itself quickly to the magnetizing force open-circuit cores should be used of short lengths. On the other hand, for strong magnetization long magnets or preferably closed rings are best.

In Fig. 2 two hysterisis loops are shown, both for a maximum induction of 5,000 lines per square cm. The inner narrow loop is for permalloy and the outer one for powdered iron. The illustration expresses the difference better than words. To obtain constant permeability of either iron powder cores or permalloy cores a *low initial permeability* is necessary.

Eddy or Foucault currents, though flowing in minute circuits, are sufficiently strong to cause a retardation

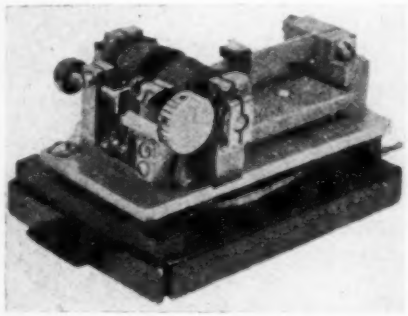

Fig. 3

effect. They are parallel to the magnetizing current but of opposite direction. Undulating currents and alternating magnetic fields cannot penetrate deeply into a solid mass; a kind of screening effect is produced, which renders solid masses unsuitable for alternating fields and necessitates the use of laminated or powdered iron cores or iron wires as the carrier of the magnetic flux.

Relays

In this discussion we confine ourselves to the telephone relays. There are in use numbers of relays of various kinds in telegraphy and other branches of applied electricity, but they do not interest the reader at this juncture. Relays form perhaps the most useful and most applied single device in telephony. There is in existence a great variety even of telephone relays, all of which to discuss would be a laborious task, it will be sufficient to mention only those which are characteristic in their action.

The ordinary relay, which simply opens and closes circuits, consists mainly of a straight soft iron core with a fixed pole-piece at one end, a frame forming part of the magnetic circuit and carrying one or more sets of contact springs. The other pole attracts the armature acting directly upon the springs. As cost enters greatly into the manufacture of relays an extremely simple relay has been produced, which as a rule makes only one single contact. This relay has a double core and is known as the flat type relay. Whatever the design of a relay may be, there is a normally open magnetic circuit, the airgap of which may be as small as half a millimeter (20 mils) and as large as two millimeters (80 mils). The pull of the relay, when operating, has to close this airgap against the pressure of the springs. This pull is not constant, because the magnetic field in the electromagnet changes from the moment the circuit is closed until the spring contacts are made. The strength of the magnetic field depends on the ampere turns on the core or cores, and may be nearly proportional to the square of the number of ampere turns at low magnetic saturation, but with increasing saturation may fall to perhaps a lower power than the first. An excitation with 30 ampere turns may be considered weak, while an excitation with 1,000 ampere turns is an extremely strong one. The ratio between pull and ampere turns determines the sensitiveness of the relay

The springs must be strong enough to assure a continuous and sufficient opening of the contacts after release, and they must not show any fatigue. A spring pressure of 10 grams (one-half ounce) is very low, while a spring pressure of 500 grams (22.5 ounces) is high. A contact pressure of 20 grams (1 ounce) minimum is required for relay contacts appearing in series with talking circuits, in order to give satisfactory and reliable operation. Strong springs cause a quick armature release, which in some cases may be a desirable or even necessary feature. Of more importance is a quick attraction of the armature, that is, the time from closing of the circuit through the relay winding to the closing of the contacts; on the average one can count on a closing time of 10 meters (32 ft.) per second. The stronger the excitation and the lower the inductance, the quicker the armature action. To obtain security of action of the relay it is advisable to give it a good factor of safety, a factor of 2 means that the excitation required to just move the armature out of normal is doubled. To prevent sticking of the armature a brass pin may be inserted in the core.

"Slow acting relays" have been used in many circuits to retard the pulling up or falling off of the armature in such a manner that it cannot close or open the circuit momentarily but only after elapse of an interval. An example of a slow acting relay is to be found in automatic operation, when a number is set up on the dial. Associated with the switch to be operated from the dial is a line relay which is actuated in unison with the impulse springs. Each release of the line relay causes the vertical magnet of a switch to take a step. The switching over from vertical motion to rotary motion is performed by a slow release relay which is controlled by the line relay. Only when the line relay comes to a prolonged rest can the slow release relay effect the switching.

Another example of a slow acting relay was given in an article on the development of the modern ringing equipment in a recent issue of the TELEPHONE ENGINEER.

To effect the slow action mostly a copper sleeve or ring is laid around the magnet core, taking up about one-third of the winding space. In this ring or sleeve currents are supposed to be set up which oppose the change in the magnetic field, when the relay becomes energized. The retardation may be at the rate of 30 meters (100 ft.) per second.

The same or perhaps a still more effective retardation may be obtained by shunting the relay winding by a non-inductive resistance, whereby at the moment when the relay becomes energized a counter e.m.f. is set up at the ends of the relay winding, which is balanced by the bifilar winding of the resistance and which produces a field whereby the relay winding field is weakened at the moment current begins to flow through it. A retardation as high as 60 meters (200 ft.) per second may thus be effected in slow-attraction.

To effect a slow-release, the same copper sleeve on the core can be used or also a copper block attached to the one-half of the core. The bigger the block the longer the release action, which may reach 400 meters (1,300 ft.) per second. A still greater duration of the release may be obtained by shortcircuiting the relay with the copper sleeve, instead of depriving it of current. The extra current then passes through the short circuit and retains the field that much longer, whereby a retardation up to 600 meters (2,000 ft.) per second may be reached.

The ordinary relay is as a rule operated by continuous current flowing in one direction and is actuated in about one-hundredth of a second. Such a relay, when used on alternating current, would chatter. To produce a relay, the armature of which will remain closed on alternating currents, the armature must be made heavy enough, so that its inertia prevents it from following the reversals of the field.

"Polarized relays" have either a permanently magnetized core or a second winding, which produces a magnetic field too weak to attract the armature. The operating current, when producing a field

in the same direction, will attract the armature, but when flowing in opposite direction has no effect, it is then that it is strong enough to entirely reverse the excitation.

A "differentially" wound relay carries two windings of equal description but wound in opposite direction so that a current flowing through both windings at the same time cannot produce a magnetic field, but can do so when flowing through one winding only.

The best relay contacts are made of platinum, but since platinum has become rare and expensive, silver contacts are frequently used, except where the contacts are undergoing extremely severe usage. Relays with "make—before—break" contacts are hard to keep in adjustment. So are relays with mechanical devices to effect various contact combina-

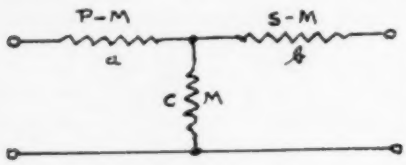

Fig. 4

tions such as "escapement" movements; they are too liable to lead to trouble and should be avoided wherever possible. Other relays again produce a stage in their movement by starting their operation with a small excitation and after the stroke is partways completed, the excitation is increased to complete the stroke. Then there are "locking" relays with two windings, one for the operation and a second one for locking so that the relay remains actuated after the operating circuit is opened.

It remains to add a brief description of the type of relays used for ringing on lines with superposed telephone and telegraph repeaters. The 20 cycle ringing equipment used on local and short toll lines cannot easily be employed on such long lines as mentioned, principally when these lines are cabled. Such lines require that the signaling current is small enough so as not to interfere with the direct current telegraph system, therefore the current must not exceed a few milliamperes. Furthermore the apparatus used for signaling must be highly sensitive. The design of the 135- and 1,000-cycle relays used in the signaling circuits satisfies these requirements in a remarkable degree.

The ringing current supply may be obtained from an interrupter, motor-generator or vacuum tube oscillator.

We will not go into a description of the ringing circuits as they are better described in connection with a discussion of the system on which they are used, but we will say something about the general construction of the relay used in such a circuit. As can be seen in Fig. 3, where a 135-cycle relay is pictured, a reed vibrates between the two magnet poles. The reed is weighted with an adjustable weight. The contact spacing is also adjustable and can be made very close, the ordinary spacing for the 135-cycle relay being about 0.0015 inch (0.038 mm.). The air gap between the magnet poles can also be regulated. The adjustment screws for all this are plainly visible in the figure.

This type of relay is very sensitive as stated before; it will operate on a current of about 0.25 milliampere. The relay is cushioned by placing a padding in the mounting, which will protect it against vibration from outside sources. The action and character of this type of relay is similar to that of the harmonic ringer. The principle underlying the operation is that a pulsating or alternating current on flowing through an electromagnet, in front of the poles of which an iron reed is fastened rigidly at one end, will tend to vibrate the reed in unison with the pulsations or alternations of the current. It is also a well-known fact that a reed of a given length and given weight at the free end will vibrate a certain number of times per second under ordinary conditions. It was discovered that a given reed placed in front of an electromagnet, as stated before, would only respond to a current the pulsations or alternations of which equaled the rate of vibrations of the reed.

The Telephone Transformer in General

The telephone transformer differs from the power transformer in that it has to transmit currents of very low intensity and of a wide range of frequencies, hence it does not lend itself as readily to calculation as the power transformers. In reality the telephone transformer serves more as a circuit coupling instrument than as a transforming device. The particular requirement that it must transmit efficiently both ways renders its design still more difficult.

Since the introduction of the repeater the demands made on a transformer as regards its efficiency have been more severe. It is in the first place necessary to terminate toll and long distance lines in transformers before being carried through the office. Transformers frequently have to be employed also at junctions of toll and long distance lines where the lines to be connected differ in their impedances. All these requirements have to be taken in consideration when designing transformers. Repeater operation in particular demands careful proportioning of transformers to avoid reflection losses and to prevent "singing." In all such cases a high grade of impedance balance must be attained, which is also necessary in repeating coils for phantom circuits and common battery cord circuits. Repeating coil is only the name of one type of transformers. Another type is the open magnetic circuit type as used in induction coils. A third type is the shell type.

The efficiency of a telephone transformer is determined by the loss of power in transmission caused by it, which is expressed in transmission units. The smaller the losses and the better the impedance balance the greater the efficiency. In practice it is hardly ever possible to find two circuits of exactly equal impedance coupled together by a transformer.

Equivalent Network of a Telephone Transformer

The action of the telephone transformer and its proper design to render the losses caused by it in transmission a minimum has been analyzed by Mr. W. L. Casper* and Mr. K. S. Johnson,* members of the technical staff of the Bell Telephone Laboratories. They select as starting point the equivalent "T" network of a two-winding transformer, which is shown in Fig. 4, which is composed of three impedances, marked "a," "b" and "c." The series arms "a" and "b" consist respectively of the differences of the primary and mutual impedances P and M, and the secondary and mutual impedances S and M, as indicated in the diagram. For a unity ratio transformer, that is, a transformer which couples two circuits of exactly equal impedance in magnitude, but opposite in phase, the arm "a" will contain the ohmic resistance of the primary and the arm "b" the ohmic resistance of the secondary. The leakage impedance will be divided between them. The mutual impedance in the arm "c" equals $K\sqrt{P_o S_o}$, where K is the coupling factor, P_o the primary impedance less the primary ohmic resistance and S_o the secondary impedance less the secondary ohmic resistance. As the mutual impedance is dependent on P_o and S_o, any factors which enter into P_o and S_o will also enter into M. The reactance components of these impedances depend on the number and distribution of turns in the windings and dimensions and permeability of the core. The resistance component is made up of an effective resistance due to hysterisis, eddy current and dielectric losses.

The two writers measure the efficiency with which energy is transmitted by comparison of actual transformers with an "ideal" transformer, which is one which introduces no losses and has the best ratio to connect the two circuits, of which the primary and secondary form parts. We will not follow their discussion but in-

*Telephone Transformers by W. L. Casper, Journal A. I. E. E., March, 1924. Transmission Circuits for Telephonic Communication by K. S. Johnson. D. Van Nostrand Company, New York, 1927.

stead we will present some practical information on the various types of transformers used in telephone operation.

The Induction Coil

The current flowing and fluctuating in the primary circuit of an induction coil which contains the transmitter, magnetizes the iron core of the coil, and the variations in the magnetic field induce fluctuating currents in the secondary circuit corresponding to the waves produced by the transmitter in form but lagging in phase by a quarter of a wave-length. As a rule primary and secondary winding have the same energy, but the induced currents are of higher potential and lower intensity than the primary currents and consequently better suited to overcome high line resistances, and may be adapted to almost any kind of a line by properly proportioning the windings of the coil.

As in the design of a core suitable for a telephone induction coil, the magnetism produced by the quick variations in the currents must always be proportional to the strength of the current, hysterisis must be kept low and Foucault or eddy currents must be avoided; a bundle of very thin wires of very soft iron is most effective in this case. The wires vary in size from No. 20 to No. 24 B. & S. gage and in length from 3¼ to 4¼ inches. The wires are annealed and varnished before they are bundled. Norway iron is mostly used. Besides open cores also closed cores made of laminated iron are found in practice. The winding of the coils ranges from 0.3 to 0.8 ohms for the primary and from 14 to 200 ohms for the secondary in local battery work with open cores; for closed cores 1.4 ohms has been used in the primary and 29 ohms in the secondary winding. For common battery work an induction coil with a primary of 17 ohms and a secondary of 26 ohms as well as a primary of 16 ohms and a secondary of 22 ohms are in use for open cores; for closed cores a primary resistance of 29 ohms and a secondary resistance of 32 ohms is suitable. The open core induction coil is not particularly efficient, but that is not so important as the requirements are not severe as far as impedance and frequency of the circuit are concerned on which they are to be used, when the simplicity of construction of the coil is taken in consideration.

Repeating Coils

In a cord circuit where simply a separation of the two halves of the circuit is required, the ratio of transformation can be one to one; that is, both primary and secondary can have the same number of turns. Repeating coils have a closed magnetic circuit, which may be formed in various ways. In cord circuits like the regular common battery circuit for local service, a compartively short core of soft iron bent into a U shape, the outer shell of soft iron completing the closed magnetic circuit, has been used for a repeating coil for only talking through. Such a repeating coil may also be given toroidal form when the outside casing is independent of the ring core. A successful repeating coil has its core made of high-silicon steel laminations.

When, however, the same repeating coil is to be used for talking through and ringing through, as frequently is the case in magneto switchboards for the operation of ring-off drops, and also in toll boards, it must be kept in mind the difference between ringing and talking currents. The former have a comparatively low frequency of less than 75 cycles per second, while the talking currents have a frequency from 30 to 3,000 cycles in

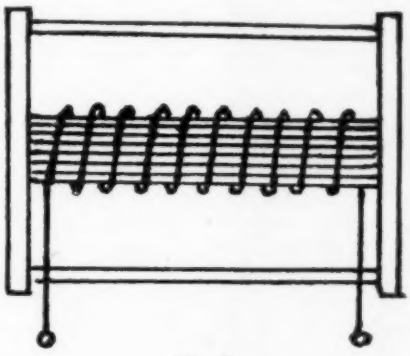

Fig. 5

round figures, and consequently require a small amount of iron in the core against a large amount for ringing current. To accommodate both, the coils for ringing through and talking through have been given a core of soft iron wire, the core being made long enough to bend over the outside of the wiring after it is put on and thus forming an iron-clad structure, or the core has been laminated, the laminations extending outside the winding coil and forming with the casing the closed magnetic circuit as shown in Fig. 5.

With a still better knowledge of the properties of powdered iron and its alloys such as nickel, the design of repeating coils and any kind of coils or transformers having an iron core will surely experience considerable modification.

Transformers in Repeater Circuits

The discussion of the telephone repeater in the TELEPHONE ENGINEER of September, 1928, contained references to a repeating coil or bridge. This coil is differentially wound, forming a symmetrical transformer, to the middle of the winding of which the "input" circuit is connected. This bridge repeating coil is a three-winding transformer, which serves also as "output" transformer. This transformer and the "input" transformer are of the shell type, the core consisting of I and E shape laminations, the I part and E part butting together to form the core. The spool carrying the winding is slipped on over the center limb of the E. The two core parts are held together by means of two brackets which are held in place by four machine screws.

The wire used in these transformers ranges from No. 18 to No. 44 B. & S. gage, and is enameled. In some cases the larger sizes are covered in addition with cotton insulation and the smaller sizes with silk.

To secure perfect insulation of the transformers so that they will withhstand the severe conditions of atmosphere placed upon them in warm and humid countries and also as protection against corrosion due to salts in material and moisture from handling, the windings are placed in a moisture resisting compound of oil or wax, baked thoroughly and treated under a vacuum.

American Telephone Vice-President Dies

Thomas D. Bowen, vice-president of the American Telephone and Telegraph Company, who has been employed by the company for thirty-five years, died September 24 at the Medical Center, New York, affer an illness of two weeks. He was sixty-three years old.

Mr. Bowen was born at Pentypridd, Wales, and came to this country as a boy. He became executive assistant to Theodore N. Vail, former president of the telephone company, which post he held for fourteen years until 1925 when he held the same position under H. B. Thayer, who succeeded Vail.

He was elected vice-president of the company eight years ago. He was treasurer and trustee of the Welsh Congregational Church and was greatly interested in Welsh affairs in this country. He was also president of the St. David Society of New York.

Radio Raises Living Standard

A report on "Recent Economic Changes in the United States" based on a survey begun in the United States in 1928 states that there is, perhaps, no more dramatic illustration of a rising standard of living than the growth and development of radio in recent years. This newest application of electricity has found its way into millions of homes, the report says. On January 1, 1928, there were 7,500,000 sets in use. Yet about 70 per cent of American homes are still without the radio. This report is made by a committee appointed last year at the president's conference on unemployment. Herbert Hoover was chairman of the committee but last year Mr. Hoover being unable to continue Mr. Arch W. Shaw served as acting chairman.

Phantom Circuits

This Is Another Very Interesting Article in a Series

By B. C. BURDEN
Lincoln Telephone & Telegraph Co.

General

The phantoming of open wire circuits in the case of long distance toll lines is an almost universal practice. The utilization of the phantom principle for exchange rural lines has, however, never been used to a large extent. Some of the companies that have tried out phantomed farm lines like them fine, while others have abandoned them because of various trouble that have arisen in connection with their use.

There is but little question that the phantom principle can be utilized to good advantage in many instances in the small exchange provided that the underlying principles of its operation and the maintenance of phantom circuits is understood. The large operating companies over the country do not as a rule recommend the use of phantomed rural lines. This fact does not indicate, however, that the small Independent plant cannot use phantomed rural lines to advantage. The need for complete standardization in the large companies have made the use of phantomed circuits on rural circuits somewhat undesirable.

This article discusses the general theory of the phantom circuit, line requirements of phantom circuits, methods for phantoming rural lines, transposition design for phantomed and non-phantomed leads, and phantoming costs. It is suggested that the various phantoming arrangements discussed be given serious consideration in connection with the reduction of crosstalk in grounded line exchanges. If good coils are used and the various requirements as to wire resistance, etc., are followed, there is no reason why much of the crosstalk that now exists in grounded plants cannot be eliminated.

Phantom Circuit Theory

Phantom circuits consist of additional voice paths which are obtained from the regular metallic circuits by means of an arrangement of repeating or retardation coils. These coils are so connected in the circuit as to cause the voice current of the phantom branch to pass over the regular metallic pairs without being heard by those talking over the circuits on which the phantom circuit is "superposed."

Fig. 1 illustrates schematically the manner in which the coils are connected in the circuit, and the paths taken by the phantom voice currents and those taken by the regular metallic voice currents.

In dealing with phantom circuits it is customary to refer to the metallic circuits over which the phantom voice current passes, as "side circuits." They are also referred to, in some instances, as "physicals." Referring again to Fig. 1 it will be noted that the phantom voice current

Fig. 1—The straight phantom circuit

(represented by the wavy arrow) divides at the mid point of the repeating coil and passes out through the line wires to the distant coil, the current flowing in the same direction in the two wires of each side circuit. The flux generated by the two halves of the repeating coil, through which the phantom current passes, would obviously neutralize itself and cancel out, hence no voltage will be created on the office side of the coil. At the distant end the current converges to the mid point of the coil and thence to the phantom jack on the switchboard. No voltage will be induced at either of the side circuit jacks for the same reason as cited above. Successful working of phantom circuits depends upon an equality of current in the two halves of the phantom coil. Where an inequality of current exists in the two halves of the coil, a magnetic flux will be set up which will induce a voltage on the office winding of the side circuit coil, resulting in severe crosstalk, between side and phantom.

A consideration of phantom circuits is greatly simplified by thinking of the phantom circuit as being composed of four wires with two wires bridged together for each of its sides.

The Three Fundamental Phantom Arrangements

There are three arrangements by which circuits may be phantomed so as to produce additional circuits in excess of those which the facilities under consideration would normally provide.

These arrangements are:

No. 1.—The "straight" phantom which consists of one metallic derived circuit from two metallic side circuits.

No. 2.—The "half phantom" consisting of one derived grounded phantom circuit from one metallic circuit.

No. 3.—The "compound phantom" or three derived metallic phantom circuits from four metallic circuits.

The "straight phantom" is the most common arrangement of phantoming and is the type used on practically all of our long distance toll lines. Fig. 1 represents this class of phantom.

The transmission over a straight phantom circuit is theoretically better than that obtained over either of the side circuits on which the phantom is superposed. In practice, however, the phantom is generally considered to be about equal to a side circuit in transmitting efficiency. The reason that the phantom circuit is theoretically better is the fact that the phantom voice currents travel over four wires instead of two hence the ohmic resistance would be halved. Losses in

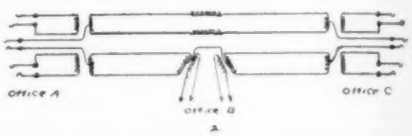

Fig. 2—The straight phantom circuit with balancing coil in non-terminated side circuit

the repeating coils used, tend to offset this gain on the phantom circuit. The transmission over side circuits of a phantom group is slightly poorer than that of a similar non-phantomed circuit. This difference is also due to repeating coil loss. With the older type coils this loss was quite appreciable but with present day coils it is very low.

Various Arrangements of Straight Phantom Circuits

It is not necessary that a phantom circuit terminate in the same office as the side circuit on which it rides. In many cases a phantom circuit is carried for miles first by one set of side circuits then by another.

It is sometimes found desirable to terminate one side circuit of a phantom group but to extend the other side and the phantom circuit through the first point of termination to some distant office. In cases of this kind the side circuit not terminated and an additional circuit which extends to the desired office are used to carry the phantom circuit on to its destination. In order that the resistance of the non-terminated side circuit and the two terminated side circuits is the same, it is necessary to place a balancing coil in the non-terminated side circuit. This balancing coil adds enough series resistance to the non-terminated

side to balance the resistance imposed by the two line windings of the terminated side circuits of the group. Fig. 2 illustrates this use of the straight phantom.

Occasions also arise where it is found desirable to extend the phantom by means of a physical circuit from the point of termination of the two side circuits. This is shown in Fig. 3.

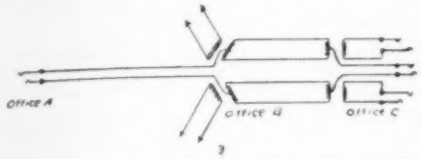

Fig. 3—Extension of a phantom circuit by means of a physical circuit

Essential Requirements for Successful Straight Phantoms

The essential requirements for successful "straight" phantom circuits are:

No. 1.—The line wires of the side circuits must be of the same gauge and kind of wire.

No. 2.—The overall resistance of the two side circuits or combinations of side circuits, that make up a phantom circuit, should be the same on each side between the points at which the phantom is superposed or carried by the sides.

No. 3.—The side circuits must free from leakage path to earth.

No. 4.—The line windings of the repeating coils or retard coils must be perfectly balanced electrically, i. e., the two halves of the coil must be of identical impedance characteristics.

No. 5.—The side circuits must be properly transposed so as to neutralize the effects of induction from external sources such as power lines and from other physical and phantom circuits on the same lead.

No. 6.—The side circuits of a phantom group must likewise be so transposed as to cancel out the crosstalk that is created within the group from side to side and from sides to phantom. A failure to meet any of the requirements given will result in "crosstalk" between sides and phantom or between the phantom group and other circuits or power lines.

The maximum difference in ohmic resistance that is generally permitted on high grade toll phantom groups is as follows:

Allowable difference in total resistance between the two wires of a side circuit.
6 ohms per 100 miles of cct.

Allowable difference in total resistance between the two side circuits.
6 ohms per 100 miles of cct.

Modern repeating and retardation coils are sufficiently well balanced so that little crosstalk results from the inherent design of the coil. However, if the windings are improperly connected to the lines (and this is easily possible) severe crosstalk will result. Lightning sometimes shorts out a portion of the line winding which of course results in crosstalk, as the magnetic flux due to the phantom current in the two halves of the coil is unequal and therefore induces a voltage on the office winding of the coil.

In the latter part of this article the transposition requirements are discussed in detail. A correct transposition layout is very necessary for phantom circuits, much more so, in fact than for non-phantomed circuits.

The Half Phantom

The "half phantom" or grounded phantom as it is sometimes called, refers to any phantom arrangement where the phantom circuit uses the line wires of a metallic circuit for one leg, and the ground as the other.

It is obvious that a "half phantom" must partake of all of the objectionable characteristics that are common to grounded lines. This fact must be kept in mind when dealing with half phantoms.

The Application of Half Phantom Circuits to Rural Plant

Half phantoms are most useful in the small plants where the number of circuits carried on a lead is small. Most of the large operating companies do not

Fig. 4—The half or grounded phantom

use "half phantoms" for the same reason that they do not use grounded lines. But nevertheless the half phantom offers an economical means of gaining an additional grounded circuit from an existing metallic circuit and in many cases is a useful expedient in the small exchange.

Half phantoms are occasionally used for bringing in a group of outlying subscribers who are located along the route of a metallic free service trunk or other unimportant circuit. If only one or two subscribers are to be brought in and they are some distance apart, it may be found desirable to install a separate coil for each subscriber. Retardation coils which are provided with a center tap are preferable to repeating coils for situations of this kind.

Half phantoms have also been used for bringing in a non-important tributary office to a toll center, where the tributary office is located along the route of a metallic circuit that can be used to carry the half phantom. The use of half phantoms for toll or trunk circuits, however, is never recommended because of the importance of maintaining toll service on a high standard. If the side circuit on which a half phantom circuit rides does not terminate at the same point as the phantom, then it is generally desirable to use retard coils as mentioned above. Retard coils do not break the physical continuity of the line wires thus make testing less difficult.

The most common use of the half phantom is as shown in Fig. 4. As with the "straight phantom" it is feasible to extend a half phantom circuit to any desired point by merely bridging the mid points of the line windings of the repeating coils on which the phantom rides.

A half phantom circuit picks up noise and crosstalk in proportion to the circuit length. The magnitude of induction picked up in a given situation will be slightly greater than that picked up over a single grounded line of the same length.

Where a straight phantom group exists it is possible to obtain a half phantom circuit by means of an additional repeating coil as shown in Fig. 5. This arrangement gives two metallic side circuits, one metallic phantom, and one half or grounded phantom circuit from four wires. An arrangement of this kind is sometimes advantageous where the half phantom circuit can be used exclusively for company business leaving the regular circuits free for toll use.

Requirements for Half Phantom Circuits

The same requirements exist for "half" as for "straight" phantom circuits although it is *much more imperative* that the lines carrying half phantom circuits be kept perfectly free from leakage to earth, otherwise severe crosstalk will take place from the half phantom into the side circuit. This is one of the reasons that grounded phantom circuits are not used to a greater extent.

Where it is necessary or desirable to use two half phantom circuits on the same lead, they should be built up on circuits that are not adjacent. For example pins 1-2 and 9-10 represent the best possible arrangement as both the separation and the shielding effect of intervening wires tend to reduce the crosstalk that would normally result from the inductive coupling of the two half phantom circuits.

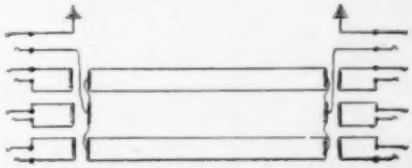

Fig. 5—The half phantom circuit superposed on a straight phantom group

The Compound Phantom

The compound phantom is of but little practical value because of the complexity of transposition design which the use of this type of phantom circuits would entail were they used.

The obtaining of seven full metallic circuits from eight wires is a very attractive feature and were it not for the difficulty in attempting to transpose a

compound phantom group, this type of phantom would probably be used to some extent. Fig. 6 illustrates the arrangement of a compound phantom group.

The writer does not know of a single instance where a compound phantom has ever been used.

Rural Line Phantoms

The principal objection against grounded rural lines is their prolific tendency to crosstalk. Crosstalk between paralleling grounded circuits is, as we all know, many times that of paralleling metallic circuits of equal length. The reason for this is evident when we consider the respective inductive fields of these two types of circuits.

Crosstalk as we know is caused by the electric and magnetic fields of one circuit creating a voltage on adjacent circuits by induction. Now the two

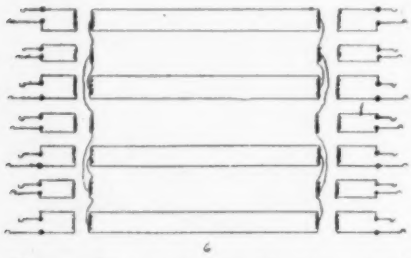

Fig. 6—The compound phantom circuit

sides of the inducing circuit each set up a voltage of opposite phase on the induced circuit. It is therefore apparent that if this induced voltage which results from the field of each side of the inducing circuit is exactly equal they will cancel or neutralize out and no crosstalk will take place. But to obtain this field neutralization it would be necessary that both wires of the inducing circuit occupy the same point in space. A consideration of the fact just stated will enable us to formulate a general law which will state the relationship between crosstalk and distance between the two sides of the inducing circuit, as follows:

"The crosstalk in a given circuit will increase in proportion to the increase in spacing between the two sides of the inducing circuit." Therefore it is obvious that a grounded circuit must create far more crosstalk in an adjacent circuit than would a metallic circuit, as the sides of a grounded circuit are separated from 20 to 30 feet, whereas the sides of a metallic circuit are separated only 12 inches.

The point to be gained from the above discussion is that *merely making a grounded plant metallic* is sufficient to reduce crosstalk to a small amount compared to what it is with a grounded plant. And where it is desired to make a rural plant completely quiet from a crosstalk and noise standpoint, then a few properly located transpositions should do the job.

It is interesting to note that transpositions give the effect of two wires occupying the same point in space.

Reduction of Crosstalk on Grounded Lines

Many small Independent exchanges have grounded open wire leads extending out into the rural districts three or four miles at which point the heavy lead branches into one and two wire leads going different directions.

By adding one extra wire for each three grounded circuits and locating coils at the office and at the point where the lines diverge, it is possible to make the lines all metallic throughout the parallel from office to branching point. From the point at which the lines break off they may be worked grounded. By this plan it is practical to completely reduce to a negligible value the crosstalk that would normally occur in the section of main lead if it were worked grounded.

The beauty of such a plan is that the comparatively short metallic section can be put upon good poles and given proper maintenance care, while the relatively longer and more difficult to get at single wire leads can be built on a much less ample margin. Anyone who has maintained both metallic and grounded rural lines, I am sure will testify, that a good metallic plant will give more "bugs" than a poor grounded one. It might aptly be said of the grounded plant, "it may be down but it is seldom out." This circumstance results from the difference in spacing. That is a pair of wires only 12 inches apart are much more apt to short during a windstorm, than is a grounded line to be blown off a pole and grounded. This discussion does not intend nor desire to justify the grounded line but only to suggest some possible and more or less practical plans for reducing crosstalk by means of phantoms in those plants which are still on a grounded basis.

Summary of the Various Methods of Phantoming Applicable to Rural Lines

The following summary of various phantoming arrangements indicates combinations suitable for application to the average grounded rural plant.

No. 1.—Where two grounded farm lines parallel for more than a half mile, make one circuit metallic and the other a grounded phantom. This will reduce crosstalk (if the wires are electrically balanced) to a negligible amount. See Fig. 4.

No. 2.—Where four grounded circuits parallel each other for a considerable distance (over ½ mile) and it is not desirable to string an additional pair of wires. Use a straight phantom with a four wire half phantom. This will reduce the crosstalk to a small amount between the four circuits. The least important line should be used as the half phantom. See Fig. 5.

No. 3.—Where three grounded circuits extend out into the rural district in the same direction, string an additional wire and phantom to the point at which they separate. See Fig. 1.

No. 4.—Where three grounded circuits extend some distance together and then one circuit branches off, while the other two continue on together, then a combination of straight and half phantom may be used. See Fig. 7.

There are probably other feasible phantoming arrangements that will suggest themselves if the theory of phantom lines is studied and understood.

Phantoming Costs

In the final analysis of most problems it is usually the cost factor that determines a choice. However, it is always well to carefully weigh all the factors concerned in reaching a decision as many cannot be stated directly in dollars and cents, and yet may very materially influence the annual cost of keeping an item of plant in service.

The following considerations represent some of the factors that should be taken into account in a comparison of phantom circuits with straight metallic circuits.

No. 1.—The longer the circuit mileage the greater the economy resulting from phantoming.

No. 2.—Phantoming requires a higher grade of maintenance than does non-phantomed layouts.

No. 3.—Minor wire troubles on phantom groups are more apt to cause com-

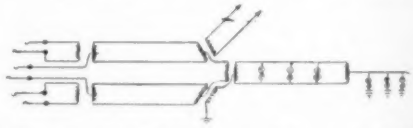

Fig. 7—Combination straight and half phantom circuit arrangement

plete interruption of service than in the case of nonphantomed circuits.

No. 4.—For a given length of lead phantomed lines require more transpositions than do non-phantomed lines for the same crosstalk limits.

No. 5.—Phantomed circuits make testing for line faults much more difficult than on straight metallic or grounded circuits.

The approximate material cost for obtaining a straight phantom circuit from two metallic circuits is as follows:

2 phantom repeating coils at	$11.00	$22.00
1 pole coil box at	4.00	4.00
1 lightning arrester at	2.50	2.50
Total		28.50

Crosstalk and Transportations in Connection with Phantom Circuits

Phantom circuits as a rule have a sort of "yen" for crosstalking. By this statement I do not mean to imply that the foregoing discussion of the merits of

(*Continued on page* 54.)

Open Wire Pole Line Construction

This Is the Third Article of a Series Upon This Subject

By RAY BLAIN

Anchors and Method of Installing

Anchors for guys on open wire lines are generally of the patent anchor type, although in some cases the guys are attached to trees or large rocks. Log anchors are still being used to some extent even though it is generally known that the patent anchor is lower in cost and can be installed with very little labor.

Various types of patent anchors are on the market all of which may be considered good. The reason that patent anchors have not proved entirely satisfactory for some users is because they have not selected a type suited to their needs. While a screw or cone anchor may be entirely satisfactory for storm guys these should not be used on a heavy corner or other heavy pull but an expanding type should be selected. The most common mistake made by users of patent anchors that have not found them entirely satisfactory is that they have not set them deep enough for their particular type of soil. Patent anchors cannot be expected to hold their maximum rated capacity in soil that caves badly.

Another mistake is the failure to line up the anchor rod and the guy wire. The right and wrong ways are shown in Fig. 1 by the solid and dotted lines.

All patent anchors other than the screw type are set in a similar manner. Usually an 8-inch hole is bored with an earth auger which is provided with an extension handle. Special tamps are provided for the expanding type and should be marked so that it can be determined when the anchor is fully expanded.

Reliable tests have been made with a dynamometer and it was found that one type patent anchor held a strain of 17,000 pounds when the anchor rod broke. There is no doubt that if the proper type anchors are selected to meet the requirements of open wire guying, and properly installed, that they will be entirely satisfactory and much cheaper than any type of log anchor that might be devised.

If a log anchor is to be used a good sound log should be selected, a hole drilled through it in the center and the sap or outer wood cut away all around the hole for several inches on one side. If possible the log should be treated with creosote. A four-inch galvanized square washer should be used to prevent the rod and nut from pulling through the log. The nut should be run onto the rod the full length of the thread and then battered to prevent it coming loose.

After the hole for the log anchor has been dug to its required depth, the anchor log should be placed in the hole on the side nearest the pole and the anchor rod trenched until it comes in direct line with the point of attachment on the pole. This will place the strain directly against solid earth. Cross logs may be used and are generally necessary in soft or wet earth but on the average open wire line will not be required.

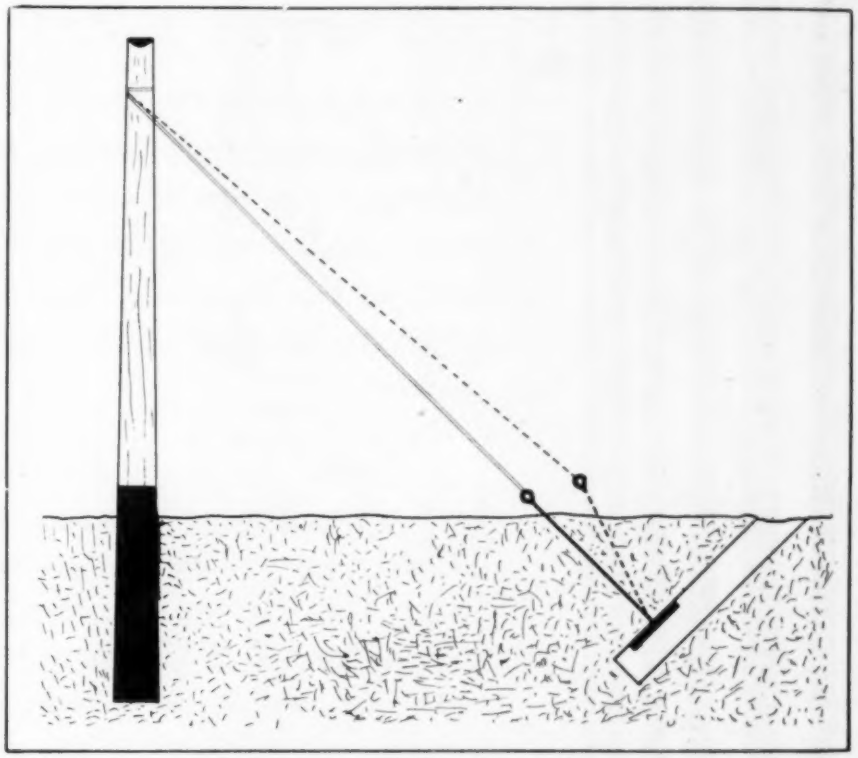

Fig. 1—Guy properly lined up to pull direct from anchor to point of attachment on pole

The most important thing to observe in setting any type anchor is to make sure that the guy will pull direct from the anchor to the point of attachment on the pole. If the anchor rod is high or low or to either side of this direct line at the ground level, the strain will cause it to gradually cut through the earth until it does come in a direct line which will permit the pole to pull out of its proper position.

When the strain is applied to a properly set anchor the lines of force radiate at angles of 45 degrees. It can readily be seen that the weight of earth affected with the average anchor will run into several tons and generally many times that of the required pull. Also the larger the surface and the greater the depth an anchor is set the greater will be its holding power.

Tree guys can be used to good advantage on some lines. When they are used strips of hardwood should be tacked on the tree before the guy is wrapped around it to prevent the growth from covering up the guy strand. An eye bolt with a four-inch square washer can be placed through the tree which will make a neater and better job but in most cases owners of trees, especially in towns, will not permit this practice.

Rock guys are very satisfactory in a rocky soil. They are usually set by drilling a hole so that an eye bolt can be set in such manner that the guy pulls at an angle of 45 degrees or less. Some of the eye bolts used for this purpose have a slit at the end and a wedge to fit so that when driven into the hole in the rock, expands, making a very secure job.

A recent feature added to a certain patent anchor is a simple arrangement to hold the nut on the rod which permits the recovery of the rod if the anchor is abandoned, by turning it, to screw off the nut, and it can then be readily pulled out. This not only saves the rod for reuse but eliminates considerable work of burying the rod or driving it into the ground on abandoned anchors.

Wire Stringing

The type of wire to be used should be determined by the length of the circuit and the grade of transmission desired.

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Formerly all line wire was either copper or iron, but recently there has come into general use a new type of wire called "Copper-Weld" which consists of a steel wire with a covering of copper welded on it. This wire combines the advantages of good transmission with a greater strength than either hard drawn copper or iron. For exchange work No. 14 iron wire is sometimes used but for rural or toll, No. 12 is the smallest that should ever be considered. Copper wire smaller than No. 12 should never be used on an aerial construction.

I do not believe that it is possible to outline any cut and dried method of wire stringing as local conditions, the

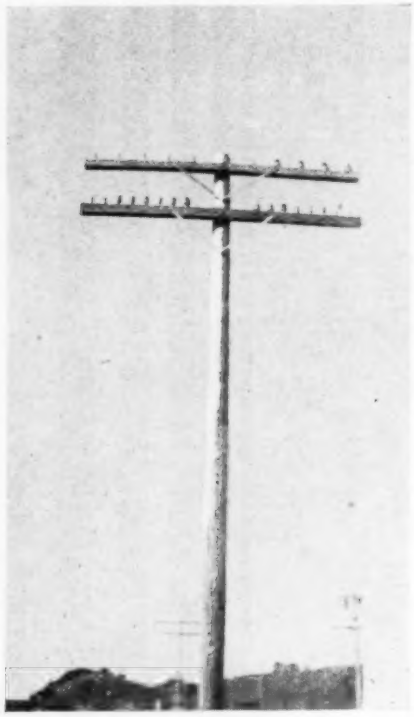


Fig. 2

tools and means at hand must be considered and utilized. If the wire is to be strung through the open country the reels can be mounted on a truck or wagon and strung out as the vehicle is driven along the line. If it is impossible to drive the line the reels can be set up at some fixed point and the wire pulled out along the line. When wire is being strung through towns or across railroad tracks, etc., it is necessary to pull it over crossarms and keep it fairly tight so that it will clear all traffic. Then there is the old method of two men carrying the reel and paying wire out as they go. This was the old Western Union method called "Bucking the reel." There was never any fun in this method and with modern ways and tools with the general adversion to hard work it is rarely necessary today.

Every effort should be made to protect the wire as it is being strung. Hard drawn copper wire if run over by truck or kinked or dented even slightly may be weakened so that it will break when the strain is applied.

When a new lead is being constructed it is common practice to mount ten reels on one truck and string a complete crossarm at one time. On smaller jobs four or five wires and many times less is considered sufficient. If the poles are not too high, and high poles are not in general favor at the present time, pikes can be used to lay the wires on the crossarms to prevent climbing of all poles for that purpose. A pike pole can be constructed with two hooks so that two wires can be laid up with one operation.

All physical and phantom transpositions should be thrown in the line by reversing the reels as the wire is being strung to prevent cutting them later and adding splices to the line. When low poles are passed where the wire when pulled may rise out of reach of the crossarm it should be left on the under side of the arm or tied in with a loose tie so that it will not bind in pulling.

Pulling Wire

Wire should be pulled in sections, the length being determined by the nature of the line. If the country is level and the line is straight the pull may be one-half to one mile in length. If the country is rough and the line has several up and down pulls with several corners the pull may be limited to one-quarter mile or even less.

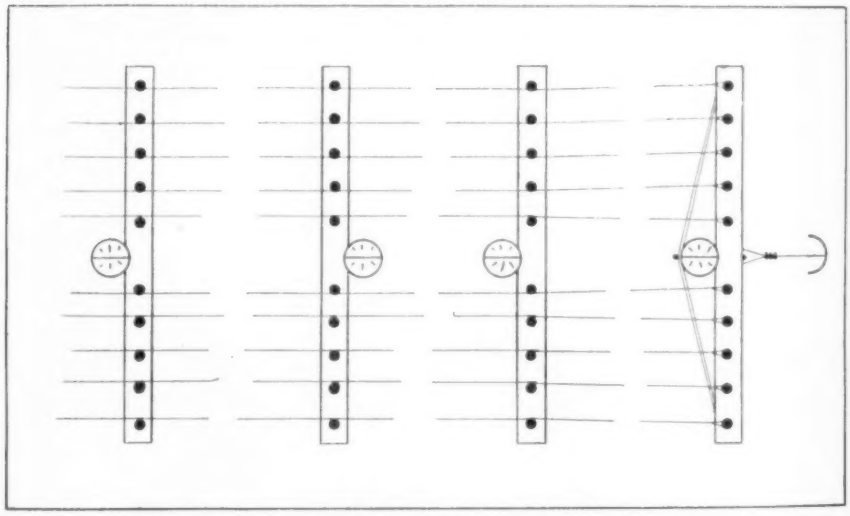
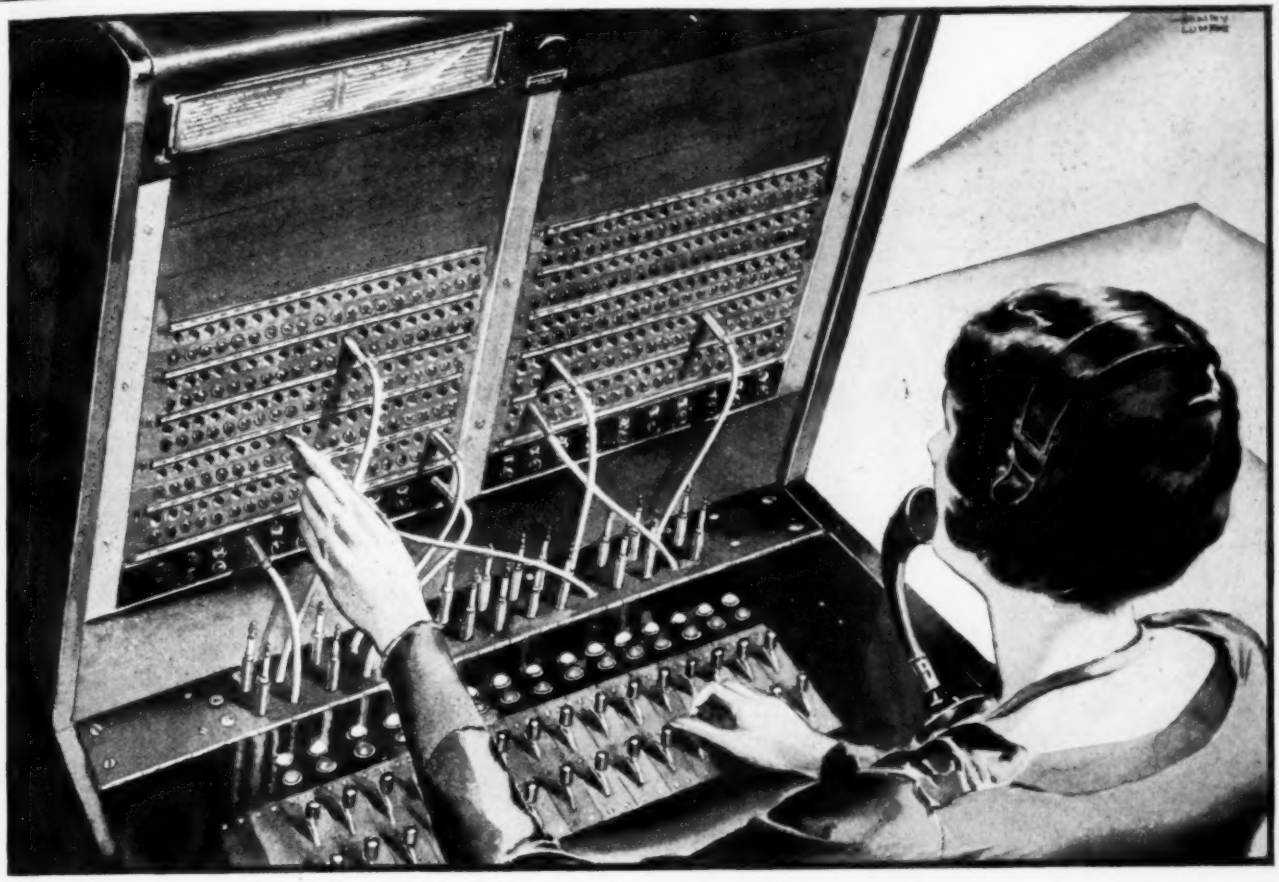


Fig. 3—Proper side of insulators to tie in wire on straight lead

The wire at the end of a section to be pulled should be passed over the crossarm and down to the butt of the pole. Equalizers consisting of a single sheave block, a short length of rope and a wire grip at each end should be provided for each pair of wires. If more than one pair of wires is to be pulled, more equalizers can be used, all of which are connected to a large pair of blocks of the two or three sheave type. The wire can be pulled with the large blocks and then leveled by pulling at the grips of the equalizers. To determine when the wire has been pulled tight enough the foreman or someone designated by him should climb a pole well back in the pull and sight for sag between two poles of an average span. Properly measured targets can be constructed with lath and mounted below each crossarm of the test span and the wire pulled until the sag is in line with the two targets.

Here is a more complicated method of determining when wire is pulled to the proper tension called the oscillating method. With this scheme the wire is pulled to the approximate tension and then started to oscillate. The oscillations are counted for a certain period and it is determined from a table when the wire oscillates for the pull desired. This more or less complicated method is not considered necessary except for large and important toll lines. I have never been of the opinion that wire should be pulled overly tight but that extreme care should be taken to see that all wires on one crossarm are level. If this is the case they will all sway together or in step. But if one wire is tighter or more slack than the rest it will either sway farther or a shorter distance than the rest and they are likely to wrap around each other in the center of the span. This theory I believe is proved by the fact that on the west coast they have 16 pin crossarms as shown in Fig. 2 on which the wire is spaced close together and very little trouble is experienced from wire tangling if it is maintained level.

I believe that one can take the following as a rough rule to follow in wire stringing and be reasonably safe: With the average span of 130 to 150 feet and with wire strung during the winter months that 4 to 6 inches should be left in it. With the same span during summer months from 12 to 14 inches of



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slack should be left. In extreme cold climates of course with wire strung during the summer months it will be necessary to leave more slack to prevent the contraction from breaking it down in the winter. It is much easier to level wire when it is pulled tight and for that reason most linemen are likely to pull all wire tighter than specified.

Splicing Wire

The old method of splicing wire by twisting the ends together with two pair of splicing clamps and then serving the ends with a pair of pliers is now obsolete. Steel sleeves are provided for iron wire and copper or bronze for copper. The sleeve should be straight and the wire should fit snugly. The wire should first be thoroughly cleaned with fine emery paper and then passed through the sleeve and out the other end for about an inch when it is bent at right angles and clipped close with a pair of pliers. A good sleeve joint will not only test OK for conductivity but will also have a tensile strength at least equal to that of the line wire and if properly made will in many cases be two or three times greater than that of the wire itself. When iron wire is to be spliced to copper or where two different sizes of copper wire are to be spliced together, the wires should be deadened each way and connected with a test connector. In twisting a sleeve, two pairs of connectors or splicing clamps should be used and the sleeve placed in the proper sized opening. Pliers should never be used to twist a sleeve unless they are provided with sleeve connectors. I do not believe in clamping the connectors on the sleeve but prefer the method of loosening first one pair and then the other. This is especially desirable in making up a sleeve connection inside slack blocks when one pair of connectors are clamped and the other twisted, all the twist comes on the wire at the grip and is likely to weaken it. When both connectors are loosened the twist is equalized.

When using sleeve connectors on a new job the end of the sleeves toward the blocks where the pull is to be made should be taped so that they will not hang up on the crossarms. If the sleeves are permitted to grab the crossarms and are pulled loose the wire is kinked or bent sharply at the entrance of the sleeve and weakens it to such an extent that it frequently breaks later.

Before the perfection of the splicing sleeves it was customary to solder all splices in line wire. This practice was not a success as the heat on iron wire generally ruined the galvanizing and weakened the wire so that breaks at splices were frequent.

I remember one time when a new man was started out over a lead with a blow torch and told to solder all splices in the line that he could reach from the poles. As there were not many of these it was thought that he would finish in an hour or two. As he hadn't returned after several hours a search was made and it was found that he was not only soldering the splices but the tie wires as well. I doubt if he has ever heard the last of this.

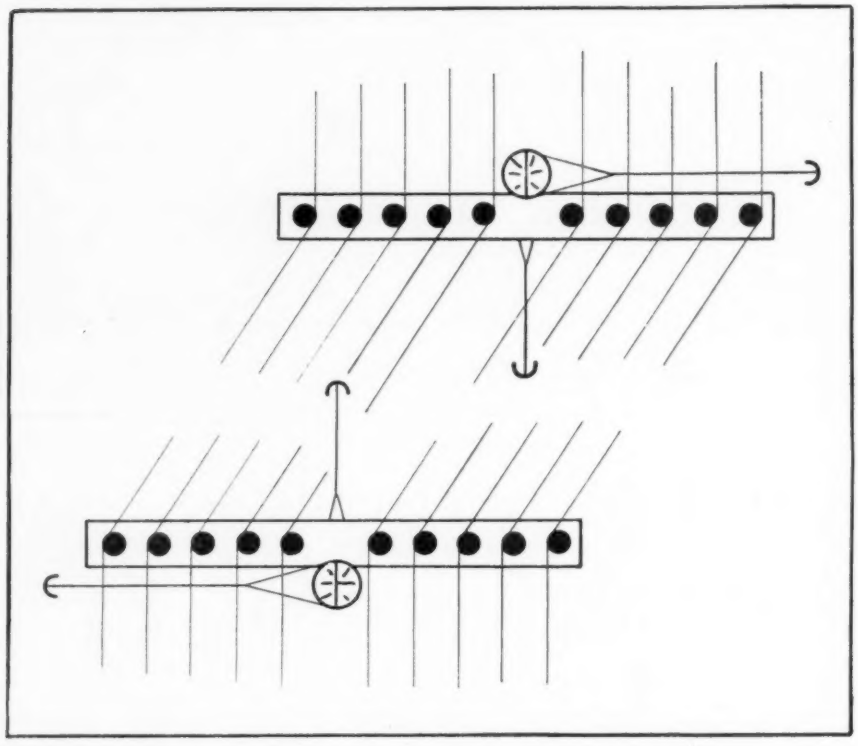

Fig. 4—Tying in wire on proper side of insulators on two pole corners

Insulators

Any good type of glass insulators will be satisfactory. Porcelain while a very good insulator if properly glazed does not appear to be entirely satisfactory for telephone work as it seems impossible to provide a groove that will hold small copper wire properly. Porcelain insulators in larger sizes for power work are quite satisfactory. There is coming into general use and favor an insulator made from Pyrex glass that has the combined advantages of being a better insulator and also being much stronger mechanically than ordinary glass. Boys can throw rocks at birds sitting on this type insulator and not hurt it any more than they do the bird.

Years ago in the Philippine Islands clear glass for insulators was found to have a distinct advantage as ants would enter the wood pins and eat them away in the colored insulator but due to the light passing through the clear glass could not bother the pin in this type. The Pyrex insulator would have this tropical advantage as they are made from clear glass.

Tying in Wire

All tie wire should have the same outer surface and be of the same size and material as that of the line wire. In tying in copper the annealed tie wire should be first passed around the insulator and lay parallel across the line wire in the groove and the ends served out on the line each way from the insulator. The wire should be held tight while tying so that it lays firmly along the line wire in such manner that no light can be seen between them. The line wire on a crossarm should be tied in on a straight line on the inside or pole side of the insulator except the pole pair of wires which should be tied in on the outside of the pin to provide climbing space. This is shown in Fig. 3. On all corners, however slight the wire should be tied in on the side of the pin as shown in Fig. 4 so that the strain comes against the insulator and not the tie wire. On a short or a high pole where the wire has either an up or a down pull the tie wire should be passed around the insulator, given one complete twist and then the ends served around the line wire, starting from either the top or the bottom depending on the direction of the pull. I am a believer in the method of bending the ends of tie wire back to the line instead of cinching and clipping them with pliers. Often when pliers are used the line wire is nicked and weakened.

In tying iron wire I prefer the method where the tie is given one and a half wrap around the line wire and the end then bent back into the groove of the insulator without clipping.

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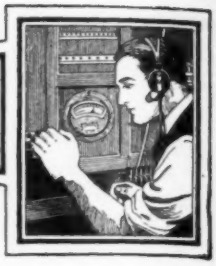
LINE AND DESK



SUBSTATION PROTECTION

All aerial construction is exposed to lightning, crosses with high voltage electric power and light wires, and other sources of current foreign to the telephone circuit.

To protect the subscriber from personal injury and their homes from the hazard thus created, as well as to prevent damage to the telephone itself, an efficient protective device should be installed with every talking set which is connected to a line or cable so exposed.

From observations made over a considerable area it appears that many of the smaller operating companies either underestimate the value of protection, or seek to economize by its omission, and are more than paying for it in repairs to damaged instruments and longer service interruptions.

The protector or "lightning arrester" consists of two essential parts: the protector blocks by means of which the two sides of the line are separated from the grounded portion of the protector by an air gap from 0.005 to 0.015 inches in thickness across which abnormal currents arc and find their way to ground through the ground wire, and the line fuses which are designed to operate and open the line when certain conditions are caused to exist.

We will now study briefly the operation of an ordinary protector with which every plant man is familiar. We will assume that the line on which the telephone in your home was installed has come in contact with some source of high voltage. The installer had placed a protector with carbon blocks, separated by a mica dielectric, and equipped with two 7 amp. fuses. When the high voltage current reaches the telephone it is choked back by the impedance of the bell coils, arcs across the gap between the carbon blocks as a path of lesser resistance, bridge the gap as it continues to flow, establishing a path to earth through the ground wire. If this condition were permitted to continue it would endanger your house and probably would burn your line wire down. At this juncture, however, as soon as the flow of current through the carbon blocks to the ground has increased to 50% above the rated capacity of the line fuse it operates, thereby opening the circuit, and the flow of current is stopped.

Fuses differ somewhat in appearance according to manufacture, but all fuses should operate uniformly according to their rating.

The pencil or tubular type of use is in general use. These have a casing of fiber, wood or porcelain and a fusible element of phosphor bronze or German silver wire or a wire made from an alloy of lead. The casing serves the double purpose of protecting the fuse wire and extinguishing the arc when the fuse is blown.

Wires from the outside should be brought in to the protector through a porcelain tube. The hole should be bored so that the tube will slope upward from the outside so that water will not run in. Otherwise the lead in wires should be taped so as to fill the entrance to the tube.

Protectors should be installed in dry places, easily accessible to the maintenance man, preferably seven feet from the floor. That will place it out of the reach of children and yet low enough that no step ladder will be required in its maintenance.

Don't put protectors in damp cellars or above ceiling where there is no stairway.

Don't place them near window curtains, in clothes closets, or where the subscriber will hang inflammable material over them. Don't pull the carbon blocks out and throw them away. It is easier to come back and clean them than it is to come back and repair a damaged telephone.

Don't strap fuses with a piece of house wire when they have burned open and thereby create a hazardous condition.

Don't install a protector without a ground wire. If you do it ceases to be a protector and becomes a mere connecting block so far as carbon arrester or metal discharge blocks are concerned.

City water pipes make the best and cheapest protector ground if the connection is made with an approved clamping device. Otherwise a standard substation ground rod should be used and all connections soldered. In soils where chemical action causes excessive corrosion rods which will not be affected by it, such as Copperweld, should be used.

Contributed by W. C. WHITE.

DID THE OFFICE BOY BELIEVE THIS ONE?

Harry Derring of Plant District Fifteen, New York, writes to tell us of a conversation between a technical man and the office boy which he overheard recently. For the benefit of the poor, ignorant little office boy the kindly technical man was describing why the Long Lines fills its aerial cable with gas. By doing this, according to his account, a pole line is made unnecessary and the cables, being filled with gas, float majestically in mid-air.

A hole, it appeared from the conversation, is drilled in the cable sheath, a gas pressure clamp is fastened over the hole and hydrogen gas is pumped into the cable. (*Bell Laboratories Record* please copy). This, of course, makes the cable lighter than air and the poles supporting it can then be removed. "Naturally," said the technical man, "the cable must be anchored or it would be blown away by a heavy wind."

Well, when we recall the terrible pranks played on us by technical people who preyed on our own gullibility, our sympathies are all with the office boy!—*Long Lines.*

MANY TREATED POLES USED

The following table taken from the annual statistical report on wood treated and preservatives used in the United States prepared by R. K. Helphenstine, Jr., of the United States Forest Service in co-operation with the American Wood Preservers' Association indicates the extent to which treated timber is employed by pole using companies. The cedars, northern and western, taken together continue to be the most used woods with southern pine following closely. The southern pine poles were all pressure treated while the cedars were practically all butt-treated.

Poles Treated, by Kinds of Wood

	Full-length pressure treatment	Butt treatment only	Total
Southern pine	1,528,441	.....	1,528,441
Cedar:			
Western red	536	1,254,613	1,255,149
Northern white	.....	555,921	555,921
Port Orford	225	8,658	8,883
Chestnut	100	284,624	284,724
Douglas fir	17,375	417	17,792
Lodgepole pine	3,000	410	3,410
All other	565	.....	565
Total	1,550,242	2,104,643	3,654,885

MAINTAINING THE TELEPHONE PLANT

The maintenance force is responsible for preserving a satisfactory condition of the plant by the elimination of such defects as may develop and for the removal

Keeping busy all the time

THE Columbia Gray Label Telephone Dry Cell keeps busy *all* the time. It is either discharging energy or building up more energy. When the hook is up it gives instantaneous power. When the hook is down the battery takes advantage of the interval of rest—it actually restores most of the energy taken out during the talking time. This remarkable feature makes Columbia Gray Label Telephone Cells last longer. Telephone experts agree that these batteries are more economical because they recuperate while idle.

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of potential sources of trouble. Maintenance work, classified as corrective, is necessary to clear reported troubles which are affecting the service. Inspections and tests are made periodically to disclose undesirable conditions, and general betterment work is undertaken if warranted, as a preventive measure to retard deterioration and avoid possible service interruptions. There are two methods, therefore, which are used in the maintenance of the plant and the proper division of activity has a considerable effect on the quality of service as well as the cost of operations. For example, if all maintenance work were performed only on reports of actual trouble, the service interruptions would have a decidedly unfavorable reaction and the cost of repairs would be excessive. Conversely, if preventive maintenance work were carried to extremes, the quality of service would be exceptionally good, but again the cost of operation would be adversely affected. Consequently, the maintenance problem is to find the economic mean between its cost and the quality of the service.—Hanse Hamilton in *The Transmitter*.

Newspaper Men Talk by Telephone While Flying

Several reporters on various New York City newspapers recently communicated by telephone from an airplane in flight to the city desks of their respective newspapers. While the reporters soared high above the Northern New Jersey countryside, they talked to their city editors as the latter sat at their desks, this being the first public demonstration ever made of two-way communication between an airplane and the ground, with the additional link of telephone land lines. Just how was this feat accomplished?

The test was in every respect a success, so successful, in fact, that when the reporters landed, some of them telephoned their offices again, only to find that their news stories were already in type and that they had come through as satisfactorily as if sent from a land telephone booth. Furthermore, it was made under adverse weather conditions, for it was overcast and rainy, but the plane easily made its way through the clouds and rain at a rate of 100 miles per hour while the experiments continued.

A Wasp-motored Fairchild cabin monoplane was used by the Bell Telephone Laboratories in making the test which was conducted by engineers of the Western Electric Company. It was virtually a "flying telephone booth," for each reporter was equipped with headphones and spoke into a hand microphone with soft rubber sides to be pressed against his face, thus shutting out the noise of the airplane.

The plane, of course, was equipped with both sending and receiving apparatus. This apparatus resembling an ordinary home radio set in appearance, except that the dials are missing, and which was developed by the Bell Telephone Laboratories and manufactured by the Western Electric Company, is very simple, compact and light—it weighs only 100 pounds complete with wind-driven and motor-driven generators. A small vertical antenna, about eight feet in length, is used for receiving and a trailing wire antenna for transmitting. The receiver is highly sensitive and receives signals at from 100 to 200 miles and is so designed that the voice of the person on land is audible above the tremendous noise of engine, propeller and wind. The receiver is mounted in a duralumin box, 12 inches long by 8 inches high and 4 inches wide, combining simplicity of control with a minimum of weight.

The receiver employs four tubes, three of which are of the screen grid heater type while the fourth is of the three-element heater type. It has two stages of radio frequency amplification, a detector and one stage of audio frequency amplification. The set operates from a generator which is driven by the action of the wind on a small propeller. The transmitter has a carrier power of 50 watts and a frequency range of 1,500 to 6,000 kilocycles is provided.

The reporters making the test were taken up two at a time behind Captain A. R. Brooks, Chief Pilot of the Bell Telephone Laboratories, and F. S. Bernhard, Bell engineer. Each paper was limited to five minutes and calls were restricted to the metropolitan area, but it has been demonstrated since that one may talk with a telephone subscriber anywhere in the United States, or hook up with the transatlantic radio telephone service and converse with Europe.

The calls that were made from the airplane to the newspaper offices in New York were transmitted via the experimental radio station of the Bell Telephone Laboratories, located at Whippany, N. J., at which point connection was made with the ordinary telephone lines to the destination of the call. The operators receiving these calls had no way of knowing until told by the reporters that the call was coming from up in the air, 2,000 or 2,500 feet above some New Jersey city or town.

As a result of this first public commercial test, it has been shown that a plane equipped with suitable apparatus can keep in constant and direct communication with its land station. The value of such development cannot be overestimated, for the pilot not only will be able to report his own progress to stations along his route, but he will be able to receive reports dealing with weather conditions and other matters of general interest to his welfare, as well as to his safety. Such adequate means of communication between ground and air has become more and more of a necessity with the rapid development of aviation, and it is a very important development in the future of aviation that the proper combination of radio and wires to meet the varied communication requirements of the aviation industry has now been found.

Book Review

The A. B. C. of Television, or Seeing by Radio, by Raymond Francis Yates. Norman W. Henley Co., New York, $3.00.

While the newest member of the electrical communications group, television, has not yet found its place in the commercial world it is arousing much interest in the laboratories and among experimenters. While much has been published in a scattered way, the book under review is the first we have seen in which is compiled information in an attempt to cover the principles employed in the various systems. It is designed for the person who desires something more than the bare theoretical outline and so furnished information from which an experimenter can construct a television set with, the author says in the preface, "every assurance of enjoying something more satisfying than mediocre success."

After an introductory chapter written in the vein of the journalist rather than the scientist, the author in succeeding chapters describes, television systems, telegraphing pictures, photoelectric cells, amplifying pictures, the neon lamp, selenium cells, the problem of scanning and of synchronizing. The last two chapters are devoted to instructions as how to build television sets for the home. The author has made liberal use of the publications of the Bell Telephone Laboratories in describing the system developed by the laboratories and also describes features of the system used by Baird, Jenkins and others.

Personal Telephone Calls in London

For a small additional charge the telephone operator will now put a subscriber right through to any particular person by name. The "personal" call will not be put through until the person named is ready to speak. The charge is 6d. on any inland trunk or toll call between 2 p. m. and 7 a. m. but between 7 a. m. and 2 p. m. the charge will vary from 1s. to 2s. according to distance. This facility will be extended to the Continent as from October 1 next.—*Anglo-American Trade*, London.

HE biggest value in a battery . . . extra life; longer service; better staying power; and a quicker comeback . . . that's the Ray-O-Vac No. 6 Telephone Battery. Compare it, test it any way you want; and you'll always come to the same conclusion: your battery money buys more . . . when the battery's a Ray-O-Vac.

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Some Interesting Facts Not Generally Known Regarding the Location of Cables Underground

By CHRIS D. STEWART

Some time ago the writer promised the readers of TELEPHONE ENGINEER an article covering the details of making a location of trouble in cables run underground and not protected by conduit.

A very good way to do this would be to describe in detail the actual location of a case of such trouble.

The writer was present at the location of a very interesting case of this kind.

The cable was a 25-pair buried about 3 feet deep and had been installed before the street had been paved.

See sketch—Fig. 1.

All pairs were wet as usual so that it was impossible to make a bridge location without running a clear wire above ground to form a loop.

A "Stewart" Cable Tester was used to make the tests.

Fig. 1

As all the pairs in the 25-pair cable were wet and none of the other 25 pairs in the 50-pair cable, the trouble was assumed to be in the 25-pair cable.

A test at C proved this to be a fact because the trouble tested east of C.

Another test at D showed the trouble to be still east of there.

Then a test at B showed the trouble to be west of B, that is, with the Cable Tester connected at the office the tone could be heard at C and D and not at B.

This located the trouble between B and D.

Another test was made at A and the tone could be heard, indicating that the trouble was between A and B.

The center of section A-B would be under the pavement, therefore, the logical proceduce would be to test on each side of the pavement to determine whether or not the trouble was under the pavement. Here a peculiar situation arose which was easily solved by the use of the "Stewart" Cable Tester.

It was known that the cable run along the south side of the alley on the west side of the street and along the property line east of the street, but it was not known where the cable crossed the street, whether it was a straight crossing or a diagonal crossing, or whether the cable ran straight east from A and north to property line and east to B, or west from B and south and west to A.

Of course the city and property owners did not want any more digging than was necessary.

If the location of the cable crossing the street could not be determined only by digging, it would be necessary to dig a trench along each side of the pavement until the cable was located or follow the cable with a trench west from B to the pavement and east from A to the pavement.

By locating the position of the cable from the top of the ground at the pavement on each side much digging was saved.

While it is not generally known, the "Stewart" Cable Tester can be used for locating buried pipes or cables of any kind of metal.

This was done as follows:

A wire was connected to the cable sheath at A and run to post 1 on the Cable Tester. Another wire was run from the cable sheath at B to post 2 on the Cable Tester. The high pitch tone which is preferable was used.

The Exploring Coil was held with the fish tail side down, close to the ground along the edge of the pavement north of the wire on the east side of the street.

The tone could be heard very plainly. The coil was held in the same plane and moved south till the tone stopped. This was at 5 or directly over the cable.

To check the position of the cable the coil was moved a foot farther south. Here the tone could be heard again. This proved that the cable was directly under 5. The tone could be heard at 4 or 6, but not at 5.

The reason for this is that when the coil is held with the fish-tail side down directly over the cable, the lines of force set up by the current on the sheath cut the coil in a neutral plane and hence do not induce a current in the coil and no tone is heard in the receiver.

While if the coil is held in the same plane but moved a foot either way, the tone can be heard because then the lines of force are cutting the coil not in a neutral plane and a current is induced in the coil which can be heard in the receiver.

The tone can be heard anywhere between the wire and a point directly over the cable. Directly over the cable no tone will be heard. Then if the coil is moved on past this point, the tone will be heard and as the coil is moved away from

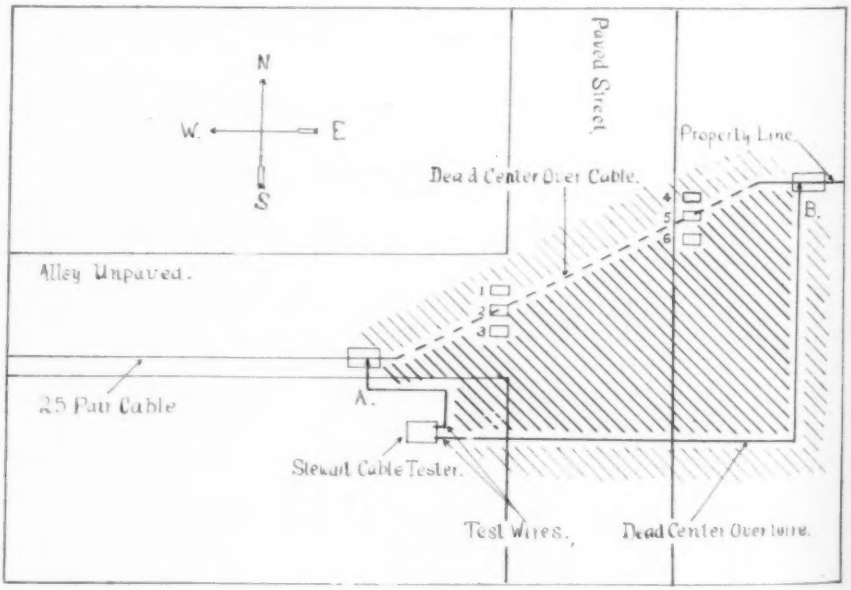
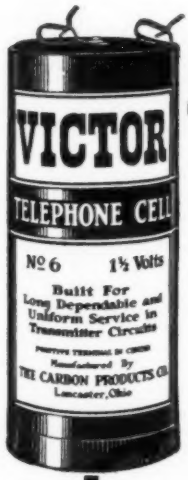


Fig. 2



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the cable the tone diminishes until it is lost.

This, of course, is only true on that part of the cable between where the wires are connected.

This test, however, can only be made with an Exploring Coil that has one unit and is neutral to the tone on the sheath.

Note sketch—Fig. 2.

With the coil held fish tail side down, the tone can be heard anywhere over the shaded portion. The tone will be louder between the wire and the cable. This is shown by the heavier shading.

The cable is located by the dead center over the cable where no tone is heard. This will be noted on sketch by the dotted line in the clear between the heavy and the light shading.

Also, if the coil is held directly over the wire which is run from the cable to the Cable Tester, no tone will be heard.

This shown in sketch by heavy line shown in the clear between the light and heavy shading.

The cable was then located on the west side of the street the same way and the cable was located at 2. That is, the tone could be heard at 1 and 3, but not at 2, this indicating the cable was at 2.

These tests required about 15 minutes time and very little labor, whereas, to have dug a trench along the pavement until the cable was located would have required considerable work and time.

Tests were then made with the Cable Tester at 2 and 5 and the trouble was determined to be under the pavement.

It was then decided to push a piece of pipe across the street with a pipe pusher and pull a cable through the pipe to replace the defective cable.

The above tests including all tests locating the trouble between A and B were made and the trouble located in three and one-half hours.

This Cable Tester can also be used for locating trouble in aerial cables, switchboard cables, or house-wiring.

Anyone desiring more information regarding this instrument may obtain it by writing Stewart Brothers, Ottawa, Ill.

Jasper, Indiana, Gets New Kellogg Switchboard

Real cooperation between the citizens of Jasper, Indiana, and the Southern Indiana Telephone & Telegraph Company has resulted in one of the finest and most modern telephone systems in the middlewest. The latest improvement, which assures the subscribers of the best service possible that can be furnished, is the installation of a new full feature Kellogg switchboard on June 21st.

Realizing that the quality of its telephone equipment is an indication of the progress and prosperity of any community, the Southern Indiana Telephone & Telegraph Company made their choice of a suitable board after much careful consideration. The Kellogg switchboard was chosen as best suited to serve the thriving industrial center, Jasper, Indiana.

The fact that more office desks are manufactured in Jasper than in any other city in the world justifies its title, "The Desk City." The four desk factories located here produce about 2,000 desks weekly. A large office chair factory, a novelty furniture factory, and a plant producing tops and panels are among the other leading industries. A large saw mill and a veneer mill produce much of the raw material used in the other woodworking plants. Some of the other industries located in Jasper are a glove factory, two flour mills, a grain elevator, an ice factory, a soft drink plant, and a printing plant.

With an industrial life such as this, it is easy to understand that among its population of 3,500 people, few, if any, idlers are found.

The citizens of Jasper are home loving people and the residential section of town is well known for its beautiful residences, schools and churches.

The telephone history of Jasper dates back many years to the days of the Dubois County Telephone Company when a hand cranked magneto board was the height of modernity. When the Southern Indiana Telephone and Telegraph Company took over the exchange they immediately began to revolutionize the entire system. The first move was the construction of a new plant.

The completed telephone home is typical of its use—housing the two important factors that keep the wheels of business moving—the telephone and telegraph offices. The entire building is constructed of brick both inside and outside, and is practically fireproof. The walls are of cream colored brick combined with an attractive contrasting red brick terra-cotta effect.

In planning the construction of the new exchange, Mr. E. W. Welch, Secretary and Treasurer of the Southern Indiana Telephone and Telegraph Company, made certain to include every modern improvement and convenience that would contribute to the pleasantness and efficiency of the telephone house. Next to the public lobby is the cashier's office, manager's office and the workroom. The second floor consists of the operating room and a brightly furnished rest room. Light, air and comfort were specially emphasized in the furnishing and planning of the operating room. Approximately half of the public lobby is occupied by the Western Union Telegraph office.

Coincident with the completion of the new telephone exchange the Kellogg Switchboard & Supply Company put the finishing touches on the new board contracted for by the Southern Indiana Telephone and Telegraph Company, and the cutover in Jasper was soon made. The board is a two section four position common battery multiple switchboard. Position No. 1 is arranged for toll; position No. 2 for rural and positions No. 3 and No. 4 for local service. The board is equipped for 400 common battery local lines, 80 rural lines and 20 toll lines.

A great deal of the credit for the success of the Southern Indiana Telephone and Telegraph Company is given to its officers. They are continually on the alert, watching for improvements for the betterment of telephone service throughout the various communities served by the company. The Southern Indiana Telephone & Telegraph Company has recently spent thousands of dollars on outside equipment, putting in approximately three carloads of vitrified clay conduit and two carloads of cable of various sizes in Jasper, Indiana.

Mr. L. C. Griffitts, president of the company, started in the telephone field about 1897 and has remained with that work since that time.

Mr. E. S. Welch, secretary and treasurer, has had a wide experience in the telephone field; having started at the bottom and worked himself up to an important position. His telephone activities began back in 1901 with the Cumberland Telephone Company of Nashville.

The manager of the Southern Indiana Telephone and Telegraph Company at Jasper, Mr. Himsel, has had a great deal to do with the installation of the new equipment and through his efforts the people of Jasper have received the benefits of good service.

Another important cog in the smoothly running telephone system is Mr. J. E. Cline, general plant superintendent for the Southern Indiana Telephone and Telegraph Company. Mr. Cline had complete charge of the construction work at Jasper that gives the subscribers the model telephone service made possible with the new Kellogg equipment.

Bell Co. Takes Up Detroit Invention

Glenn Watson, a Detroiter who has invented a device for a long-distance transmission of voices, synchronized with motion pictures, and who recently staged a successful demonstration over a distance of three miles, announced that he was making arrangements with the American Bell & Telephone Company for a test between Detroit and New York.

According to Watson, the device will permit transmission of the actors' actual voices over a net of wires to several hundred theaters at once, replacing the present "talkie" mechanisms.

Persons who listened in on the first test reported the results much more lifelike than are obtained by apparatus now in use.

PUBLIC LIABILITY PROPERTY DAMAGE

Thrifty Bill Says

"We will pay you big dividends for 10 minutes of your time."

If you plan to attend the National Telephone Convention in Chicago, we would like to have 10 minutes of your time there to show you how you can secure Casualty Insurance, specialized to your own needs, at a substantial saving in cost.

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Ramblings

J. A. S.

In scanning the news in Transmitter-Journal down in Texas we find that the Decatur Telephone Company of that state is making repairs and in other ways improving its service. Decatur was one of the last towns in Texas to relinquish duplicate telephone service, and the story is somewhat pathetic and more or less tragic. Some five years ago the writer visited that little city of probably 3000 inhabitants. The Southwestern Bell operated there as well as the Independent exchange. The owner of the latter wouldn't sell and was unable to buy; so matters were at a standstill. The Independent exchange controlled about three-fourths of the stations and felt they had the upper hand. And what of the dear public? Decatur is located in a poor farming section on a direct line connecting Dallas and Fort Worth with Denver and other western points and was considered very important from a long distance standpoint, and the inhabitants were thoroughly sold on interborough free service, hence they were satisfied. They would not stand for a raise to enable a concern to improve the service and make consolidation, because that meant inter-county toll charges. And in the meantime the owner of the Decatur Independent exchange was struggling to pay his bills. Finally conditions got so bad that something had to be done and the Independent manager and Southwestern Bell both agreed to sell to outsiders. We are glad to see the improvements come.

* * *

And then there was the Alvord Telephone Company just a few miles west of Decatur. This exchange was owned by a young fellow, full of ambition, ability and believed in the public thoroughly. His exchange was paid for and he had A-1 credit. So he put in one of the best little exchanges in the state (the town was not large), relying upon the subscribers to grant him a fair rate for service *after* the service was improved. But he reckoned without the politician. Unfortunately a mayor and board of aldermen (Texas has no state commission) composed the high court to pass upon the rate increase. They were looking to re-election as well as desiring low rates for themselves. Hence after two or three years of litigation and after the case had gone through the Federal courts, the energetic young man with faith in humanity, was forced to sell his exchange and seek employment elsewhere. You know the moral.

* * *

Theodore Gary of Kansas City was signally honored recently when he was named chairman of a board of business men by the governor of Missouri to make a survey of the several departments of state government, its revenues and expenditures and the functioning and needs of all state institutions, education, eleemosynary and penal. The commission is to complete its work about December 1st, at which time recommendations built upon the findings of the survey will be made for the consideration of the next legislative session. No one doubts the ability of Mr. Gary; his selection showed rare judgment.

* * *

B. C. Burden, assistant plant engineer of the Lincoln Telephone & Telegraph Company, and whose very interesting articles have been appearing in Telephone Engineer from time to time, was recently promoted to the position of foreign wire relations engineer of that company. He succeeds V. A. Randall, who becomes toll fundamental plan engineer.

* * *

Engineers down at Dallas, Texas, have just finished moving a three-story brick telephone exchange eighteen feet without interrupting exchange service. Flexible water connections made it possible for every part of the building to be used while the job was being executed. Completion of the work of moving in twelve hours is believed to set a record. We'll say it's a record we would not want to undertake to lower, even in a lifetime. We'd like to see the job done, but far be it from us to want to take a ride like those loyal operators took. We'd almost as soon take a "ride" in Chicago.

* * *

Mrs. Dorothy Van Ert, formerly traffic supervisor for the Illinois Telephone Association, has been named chief operator of the Michigan Home Telephone Company of Muskegon, Michigan. She was for several years chief operator of the Emporia Telephone Company at Sabetha, Kansas.

* * *

Oil wells have been brought in a short distance from the capitol of Oklahoma, and that section of the city is being transformed into oil activities rather than a beautiful residential district. Which necessitates an altogether different type of telephone service; a large amount of the calls originating in that section now are long distance messages.

* * *

And thoughts of Oklahoma naturally turns our mind to H. W. Hubenthal of the Oklahoma Utilities Association, who annually attends the United States Independent Telephone Association convention. Hube writes us to reserve him a room where nothing will disturb his slumber. He always arrived "ahead of the hounds" and we look for him to protect his record this year.

A. L. Salt, president of the board of directors of the Graybar Electric Co., New York City, spent his usual vacation period in the Maine forests, where he has had a retreat for many, many years. Mr. Salt has rounded out almost fifty years of service with the Western Electric Graybar organizations—and yet he is not an old man, judging from his looks and activities.

* * *

And this here daylight saving time is history for another six months any way. In many towns and cities it will be a relief to again know without guessing just what time it is in the town where the call terminates. The writer has been running around all summer in his car, and was never sure whether he would reach his destination before noon or not, regardless of the hour he reached town.

* * *

Our annual invitation to make this office your loafing place while attending the convention in Chicago is extended you with the hope that you will not fail to take advantage of it. Our office force is at your service, so pay us a visit.

Studying Telephone Methods

(*Continued from page 21*)

the solenoid to pull in the plunger. This sweeps the master switch mechanism from contact No. 1 back to contact No. 10. When No. 10 is reached the lower segment arm will break the lock between springs 3 and 4 of the trip relay. This breaks the circuit to the solenoid and allows the master switch to stop on No. 10 contact. During this sweep the guide bars will pick up any line switch plungers that may have released.

Hunting Trunks

Should all the trunks be busy, all the master switch bank contacts will be grounded. Therefore the start relay will remain energized. Thus when the solenoid pulls the segment back to No. 10 trunk, the start relay will still be operated. This will complete the circuit to the locking relay, and the locking relay will remain pulled up over the progress over the 10 trunks. The master switch will then continue to sweep back and forth until a trunk is released. As soon as a contact of the master switch bank is cleared of ground, the start relay will release, the locking relay will release and lock the segment on this trunk.

The speed of the master switch is adjusted by the governor springs so that it will travel from No. 10 trunk to No. 1 trunk and back from No. 1 trunk to No. 10 trunk again at the rate of 100 to 110 times in a minute. If the start relay is held in by hand this speed can be checked with a watch, while counting the number of times the master switch completes its operations in a minute. The complete operation is called a cycle, so that we would adjust from 100 to 110 cycles per minute.

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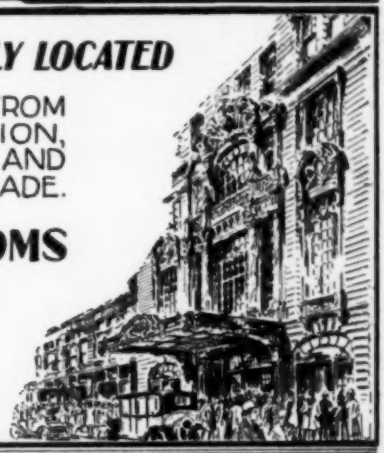

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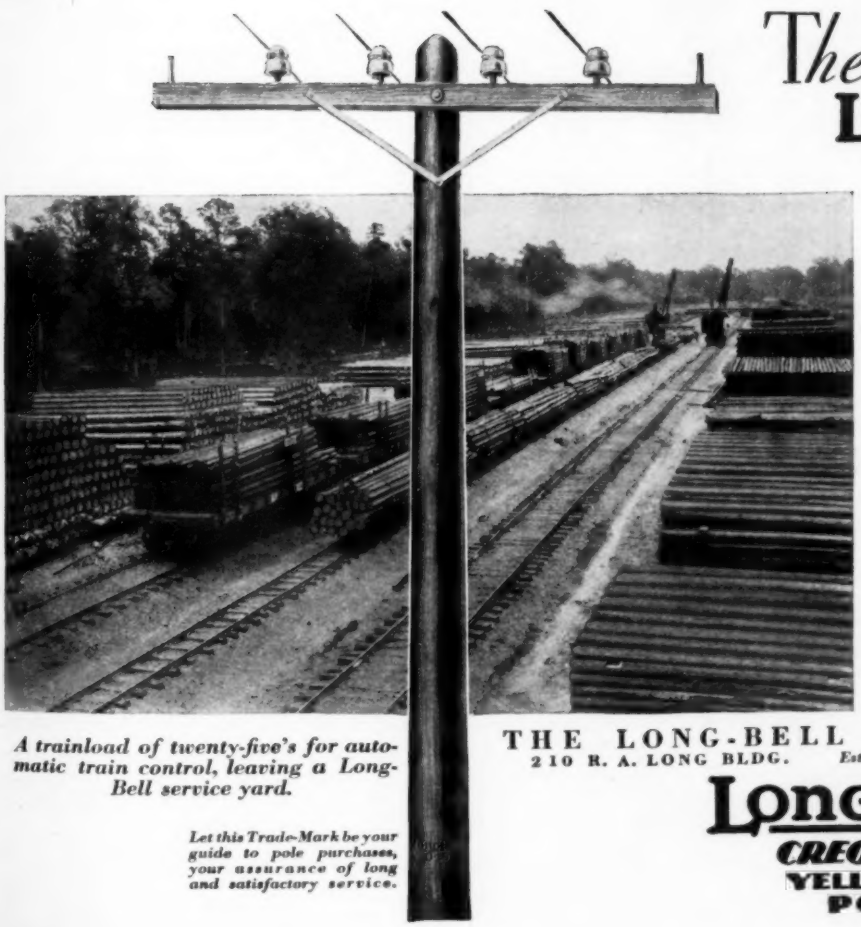

A trainload of twenty-five's for automatic train control, leaving a Long-Bell service yard.

Let this Trade-Mark be your guide to pole purchases, your assurance of long and satisfactory service.

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210 R. A. LONG BLDG. *Established 1875* KANSAS CITY, MO.

LONG-BELL
CREOSOTED
YELLOW PINE
POLES

TELERING

One of the interesting exhibits to be seen at the national convention will be that of Telkor, Inc., the manufacturers of Telering, the ringing machine which has met with so much favor among the operating companies. These machines will not only be exhibited under operating conditions, but the output wave-form of Telering will be visually demonstrated with an oscillograph. Telkor, Inc., will be prepared to answer all inquiries in a technical as well as a practical manner.

Telering is now in use all over the United States, in Canada, Mexico, Hawaii, Philippines, New Zealand and Switzerland. The U. S. War Department is using them in the Signal Corps. This widespread distribution has occurred in less than a year.

The principle upon which Telering operates has never been used before in the changing of power frequency, and during the year that it has been on the market, it has aroused much interest scientifically. While the present use of the principle is confined to telephone ringing purposes, it is adaptable to a number of other power applications which are under consideration, and its use is expected to become important in other fields than telephony.

Westinghouse KDKA Re-Broadcast in Costa Rica

Music from radio station KDKA has been re-broadcast in the tiny Central American republic of Costa Rica. Programs are constantly being re-transmitted in North America and Europe, but the feat of station NRH in one of the smallest of nations demonstrates the progress being made by radio.

Information of the accomplishment was reported in a letter from Amando Cespedes Marin, owner, operator, etc., of NRH, which is located in Heredia, Costa Rica, to Walter C. Evans, superintendent of radio operations of the Westinghouse Electric & Manufacturing Co. The excerpt from the letter which tells the story follows:

"Did I tell you that I have broadcast your station on 296 meters, using the same transmitting antenna for receiving your 26-meter wave? That is the way I do to sell my short wave sets, by re-broadcasting your themes. The radio is all a joke that makes us live even in this tropical, evergreen altitude. Oh, how I prize KDKA ever from its beginning."

Marin frequently refers to KDKA as "the big brother" of his station and evidently looks upon the Pittsburgh station as his inspiration, but his own station has accomplished feats fully as important as the re-broadcasting of the Pittsburgh programs.

For instance, broadcasting on 30.3 meters with a power of 7½ watts (less power than an ordinary light bulb) NRH has been heard all over the North American continent, in South and Central America and latest of all in Great Britain. This latest feat is attested by A. Harry Bevan, 55 Goldsmith Road, Kings Heath, Birmingham, England. This means that the program was transmitted more than 5,500 miles.

Marin is a man of inspiration, as is shown by his radio work. This enthusiasm is evident in his letters to Evans and the radio fans throughout the United States. He becomes almost lyric at times in writing of his dear NRH. A quotation from one letter gives an interesting insight into Costa Rica:

"We have 367 soldiers and out of that number 190 are members of our bands that tune happiness, BUT our great array numbers 1,457 teachers that drill our youngsters under the most modern civilized ruling."

KDKA's broadcasts to Commander Byrd in Little America are well received by Marin. "It is so clear and loud that it resembles an electric phonograph just like mine," he reports. "People have to distinguish between the two by actual proof."

Probably the biggest event in NRH's history, according to Marin, came recently when KDKA mentioned NRH's work during a broadcast. Of this Marin wrote:

"Last night, at 6:30 Costa Rica time, I had the pleasure of hearing the voice from KDKA telling the world about me and the NRH, the humblest little station merely imitating you, the almighty of the enchantment radio, of which we read in the Arab book, 'The Thousand and One Night,' 'Touch that box with your hands and the music of heavens will be at your command.'"

Correct TREE TRIMMING

THIS No. 1 Compound Lever Rope Pull Tree Trimmer is especially designed for telephone company requirements. It is operated by a rope and the drop forged crucible tool steel blade with compound leverage makes cutting extremely easy. A 13 inch metal pull lever, which greatly increases the cutting power, is placed 42 inches from the head. A spring retainer makes it possible to adjust the tension. Obtainable with sitka spruce pole 8 to 16 ft. long and extra sections with aluminum sleeve for attaching. (See illustration.)

BARTLETT MFG. CO.
743 Beaubien Street Detroit, Mich.

Churchill Cabinet to Enlarge Facilities

Chicago, Ill.—From Spencer Gullickson, vice-president, comes word that Churchill Cabinet company has acquired 40,000 square feet in addition to the three plots already occupied by the well known telephone booth manufacturers. On the new site, which adjoins that of the main plant at 2119 Churchill street, a modern plant will be constructed at an early date. This will be devoted exclusively to telephone booth assembly and final inspection.

President Has New Telephone Number

This Is the Third Change in White House Telephone Number in Half a Century

The White House telephone number has been changed and the listing under United States Government in the newest telephone directory for Washington, D. C., is now:

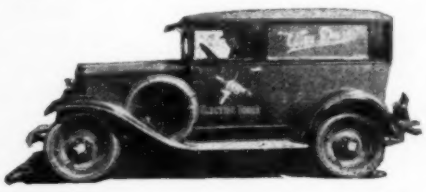
"Executive mansion, 1600 Pa. Av. NW. National 1414."

This is the third telephone number the White House has had in the history of the telephone. When the first instrument was installed in the White House on May 10, 1878, it was listed as number 1. In 1900 a new exchange was established and the White House number became "Main 6." Main 6 continued as the number through the administrations of William McKinley, Theodore Roosevelt, William Howard Taft, Woodrow Wilson, Warren G. Harding and Calvin Coolidge. Now, however, due to the extension of service, it has become necessary to make a third change, and "National 1414" is the result. When Main 6 was established there were only 4426 telephones in the city of Washington. When National 1414 became the White House number this year, Washington's telephones numbered about 154,000.

Van Dorn Electric Tool Demonstration Car

The Van Corn Electric Tool Co. of Cleveland, Ohio, is now using a new electric tool demonstration car to assist the jobbers' salesmen in demonstrating various Van Dorn tools in operation.

This car consists of an especially designed closed body mounted on a chassis



of one of the well known car manufacturers. The large rear door, when opened, shows the various electric tools in neatly arranged sections making them accessible for immediate use. This enables the salesmen to bring the tools to users so that they can prove for themselves the merits of the product.

At the present time, this car is being received enthusiastically by the trade in Maryland and Virginia so that arrangements have been made to send it or similar cars to all parts of the United States.

2-Way Phone Conversation from Train Found Possible

Two-way conversation by radio telephone from a moving train to a distant city was successfully accomplished recently on the Canadian national railways, marking a distinct improvement over the one-way apparatus that has been used for some time in Germany, says "Popular Mechanics Magazine."

If the equipment proves practical for general adoption travelers on railway trains anywhere will be able to talk to their friends from the cars and listen to the replies as easily as telephone conversation is conducted between stationary points.

Telephone Company Gives Radio Service

Plans to provide Defiance, Ohio, residents with radio in conjunction with its telephone service were announced recently by Manager J. M. Phillips of the Northwestern Telephone Co. A loud speaker will be installed in the subscriber's home and programs will be received at a company studio which will be connected up over telephone wires with the customer's speakers.

FOR SALE

2 conductor black silk desk stand and receiver cords, per set, 40c. W. E. No. 47 fuses, $6.00 per 100. W. E. No. 14 terminals, 16 pair less stubs @ $4.00. W. E. NEW 3 conductor swbd. cords with No. 109 plugs attached, 50c. Heminway No. 42 glass insulators @ $5.00 per 100.

The Telephone Repair Shop

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400 Newly Furnished Rooms
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Sample Rooms
$4.00, $5.00, $6.00
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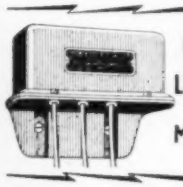

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Large selections of the finest A. C. Electric, 6, 7, 8 and 9 tube chassis and complete sets obtainable at the amazingly low prices we quote. Every modern radio improvement is embodied in these **marvelous electric radios. Backed by guarantee of satisfaction** of this 17 year old institution.

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Rural communities with homes not wired for electric radios offer a good market for battery sets, repairs and replacements. We have a **large stock of batteries, eliminators, speakers, tubes, transformers, coils,** and all kinds of accessories for battery sets. **Best known, nationally advertised goods,** such as **Cunningham, Sonatron** and **Arcturus tubes, Burgess batteries, Jewel instruments, Belden Products, Utah, Temple, Farrand** and other popular **dynamic** and **magnetic speakers.**

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Home "Talkies" to Come in Five Years, Prediction

By LEE DE FORREST

Chief Consulting Engineer, De Forrest Radio Co.

To one who has seen his invention grow from the hand made, costly laboratory audion of 1906 to the millions of vacuum tubes now in daily use it may be pardonable to accept present achievements as the ultimate in radio progress.

And I hasten to admit that no one is more astounded by what has been accomplished than I am today. Although branded as a dreamer of impractical dreams and as a dabbler in a hopeless means of communication, I have seen my audion detector, amplifier and oscillator applied to uses far exceeding my wildest flights of fancy.

Nevertheless, my sense of imagination, far from being dulled, is even whetted to a keener edge as I contemplate the future of radio. I believe we have done little more than to scratch the possibilities of our radio technique.

Rather than again fall short with my expectations of the future, I state without reserve that the achievements of years to come will be far beyond anything we can dream of today.

In the immediate future I foresee sight broadcasting coming to join sound broadcasting. I predict satisfactory television in general use within five years. I predict home "talkies," with an entire evening's entertainment in compact, inexpensive form.

I predict still more refined reproduction of music and speech, international broadcasting in place of national broadcasting, and the complete obliteration of static in every populated section of our country through still more powerful broadcasting stations joined by wire networks. We are still infants in radio!

Pioneers Many Improvements

Some time ago it was announced that the Stromberg-Carlson Telephone Manufacturing Company had been a pioneer in the application of screen grid tubes to improved radio circuits, having manufactured such sets in 1928 for the Aircraft Radio Corporation of Boonton, N. J. This pioneer experience was an invaluable aid in putting out screen gird models of proven reliability for broadcast reception, says R. S. Bookless, manager of the radio division of Garnett, Young & Co., Stromberg-Carlson distributors.

A glance through the historical files of Stromberg-Carlson recently revealed that it has been responsible for originating and developing a large number of other notable improvements, many of which are of major importance in the radio field.

For example, this company was responsible for the first "chassis" type construction used in a radio receiver, in which the complete operating element of the receiver is built into one mechanical unit, the outside casing being used only as a housing. This was incorporated in the first models in 1924. Later Stromberg-Carlson pioneered a refinement of this idea—namely the "one piece receiver chassis," mounting on one metal base all apparatus including power plant equipment.

The first use of total shielding in a tuned radio frequency receiver was brought out by Stromberg-Carlson in 1925, setting new standards in quiet operation with increased sensitivity and selectivity.

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ELYRIA, OHIO

Blair, Nebraska, Completes New Telephone Exchange

Since the days when the telephone industry was in its earliest stages, Blair, Nebraska, has enjoyed uninterrupted telephone service. Even last February when the entire telephone equipment was torn up and moved from the old building to the new exchange completed at that time, service went on with its usual smooth regularity. This unusual feat of telephone engineering was accomplished under the supervision and direction of Mr. C. M. Robinson, an installer for the Kellogg Switchboard & Supply Company. His job was to move a six position Kellogg Universal Switchboard and the supplementary apparatus to the new building, and he so planned and executed the change that there was practically no interference with service.

The telephone history of Blair is a most interesting one and is good proof of the progressiveness of this western city. For more than ten years Blair has kept step with practically every improvement of telephony. The first change was in 1916 when the Blair Telephone Company purchased a Kellogg Multiple Universal Switchboard, to replace the old magneto system with common battery lines. The new Kellogg equipment consisted of 300 common battery lines, ten toll lines and about fifty rural lines. The next year telephone efficiency was advanced another step by the installation of a wire chief's turret and a manager's cabinet.

At that time the Northeastern Telephone Company established an exchange at Blair and until 1926 the telephone sympathies of the town were almost equally divided between the rival companies.

In February, 1926, Mr. E. C. Hunt purchased the competing companies and proceeded to combine the best features of both to provide the people of Blair with the fastest and best telephone service possible. Mr. Hunt visualized an ideal system and built his plans around the service made possible by a Kellogg Universal Switchboard. His first move was to change all the cord circuits in section one of the Kellogg board to the latest design. Test circuits, meter circuits and apparatus for automatic ringing were added and a new three position section and two hundred additional lines were put in at the same time. These changes were easily made as the Kellogg Universal Switchboard is constructed so that it can be adjusted to meet the needs of growth.

The old telephone building was hardly a fitting home for the improved equipment, so work on a new exchange was started immediately. In laying out the plans for the new telephone home, Mr. Hunt was careful to provide for every possible feature of an efficient business house. The completed building with its bright tile roof and unusual door lamps might easily be mistaken for one of the fine residences characteristic of the type found in Blair. In the rear of the building is a garage that can accommodate four cars or trucks. The workshop and material storage bins in the new exchange are models of modern equipment. The office space and switchboard room are light and airy, retaining an atmosphere of business and efficiency. Wicker furniture and bright cretonne covers make the operator's rest room cozy and attractive.

With the installation of the Kellogg switchboard in the new exchange, Mr. Hunt completed the laying of additional cable which made a total of 60,000 feet of underground construction.

Besides the telephone exchange at Blair, Mr. Hunt owns and operates plants at Kennard, Calhoun, Arlington, Walthill, Winnebago and Carroll, Nebraska.

FOR SALE

TELEPHONE Exchange, Kansas. Paying exchange, well located. Extensive farm and local installations. Bargain. National Brokerage Company, Omaha, Nebr.

WANTED

WANTED—First-class cable splicer, principally maintenance and trouble work, both aerial and underground, permanent position to good man. Answer, giving references to Petroleum Telephone Company, Oil City, Pa.

RECONSTRUCTED EQUIPMENT

Kellogg No. 6B Cordless P. B. X. board with 7 local lamp lines and 2 trunk Ckts. @ $50.00—10-local and 3 trunk type @	$65.00
Kellogg No. 97 or No. 118 Common battery desk set complete with No. 404 or No. 259 Steel signal sets, straight line or 16-33-50 and 66 cycle ringer	7.00
Keellogg or Dean drop coils, 100 ohm 35c ea. 500 ohm @	.50
Western Elec. No. 329 Transmitters with back & mouthpiece @	1.25
Western Elec. No. 250 or 229 Transmitters with back and mouthpieces @	1.15
Western Elec. No. 143 Receivers with cords @	1.25
Gray 3-slot wall or desk type paystations @	5.75
Gray 5c single slot desk or wall type paystations @	1.25
Kellogg No. 30A combine line drops and jacks, per strip of 10 @	12.50
Kellogg No. 28 3-bar 1000 or 1600 ohm Bdg. desk sets @ $10.00—4-bar $10.75—5-bar (all with New Cabinet inside connection signal sets) @	11 10
Kellogg No. 22 L. C. Transmitters with back and mouthpieces @	1.10

Write for Our Bulletin

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(REFINISHED)

Stromberg-Carlson C. B. oak No. 1136, straight line $2.00
16-33-50 and 66 cycle harmonic 2.50

Leich Electric Co. oak, straight line 2.00
16-30-33-42-50-54-60 and 66 cycles 2.50

Dean Electric Co. steel straight line 2.00
16-20-30-33-42-50-54-60 and 66 cycles 2.50

Same as above, complete and tested (not refinished) $1.50 and $2.00 respectively

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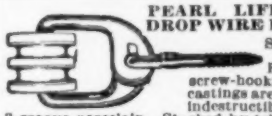

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The piano wire grip compensates for the expansion and contraction of the shank when heated and cooled.

IT WON'T LET GO.

Note Air Space and minimum contact of shank and wood.

Simply force pointed shank into handle.

A DEPENDABLE handle for work on main frames.

No. 1—7/32 to ¼ shank.
No. 2—¼ to ½ shank.
No. 2 for heavy coppers with ¼ shanks.

UNIQUE MFG. CO., Inc.
221 Whiting St. Chicago, Illinois

Phantom Circuits

(*Continued from page 28.*)

phantoming for the reduction of crosstalk on rural grounded plants is not a good move, but do wish to lay stress on the importance of a proper transposition scheme in connection with the use of phantoms.

Phantom circuits because of their nature require more consideration than do metallic circuits to keep crosstalk down. This tendency for phantomed circuits to crosstalk when conditions are irregular results from any of the following conditions:

No. 1.—Resistance and leakage unbalances on line wires and coil unbalances.

No. 2.—The carrying of phantom groups through non-quadded cable results in high crosstalk in some cases.

No. 3.—Where quadded cable is used, a capacity unbalance due to unavoidable irregularities in the twist or lay of the cable conductors may result in crosstalk.

No. 4.—Lack of a proper transposition scheme on open wire phantoms.

The remedies for No. 1 are to use good coils, adequately protect them from lightning, sleeve all open wire connections and solder jumpers, keep the arrestors free from grounds and keep the open wire free from leaks to ground.

Regarding No. 2 quadded cable is seldom found or needed in the small exchange where phantom groups are carried only a few blocks. For longer lengths of non-quadded cable carrying phantom groups, it is usually possible to pick out two pairs in the cable involved which will have a minimum of crosstalk. If considerable crosstalk is experienced in a long non-quadded cable, then it may be necessary to place the coils at the end cable terminal and bring the phantom circuits in metallic through the cable. This arrangement makes line testing difficult, however, and should be avoided if possible.

If cable is being placed and there is a possibility of future phantom groups working through the cable it should have a few quads in addition to the regular exchange pairs.

Quadded cable is made by twisting the two wires of a pair together and then twisting up two pairs forming what is known as a "quad." These twisting operations are so arranged as to accomplish the same thing that transpositions do for open wires, i. e., place each wire of a quad an average equal distance from all the other wires in the quadd. In the manufacture of cable some variation in the twists occurs and the wires do not have the same capacity values to each other. This condition is referred to as "capacity unbalance." It is possible to reduce or neutralize these unbalances by means of capacity unbalance measurements and the proper poling of the wires at the splices.

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Years in advance of the field in design, it utilizes most modern methods of transmitting power. Efficiency, simplicity and absence of "lost motion" are some of its outstanding characteristics.

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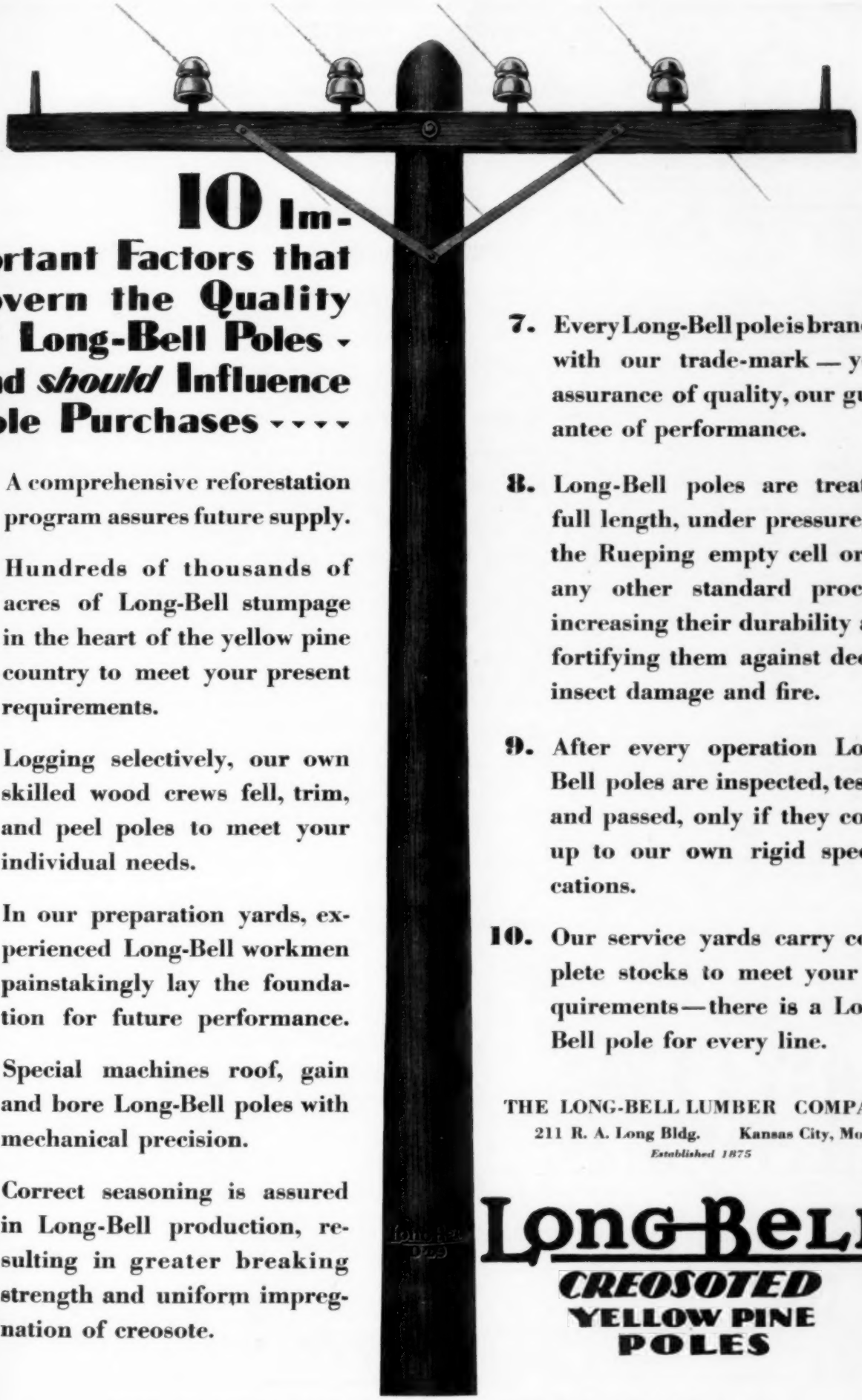

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